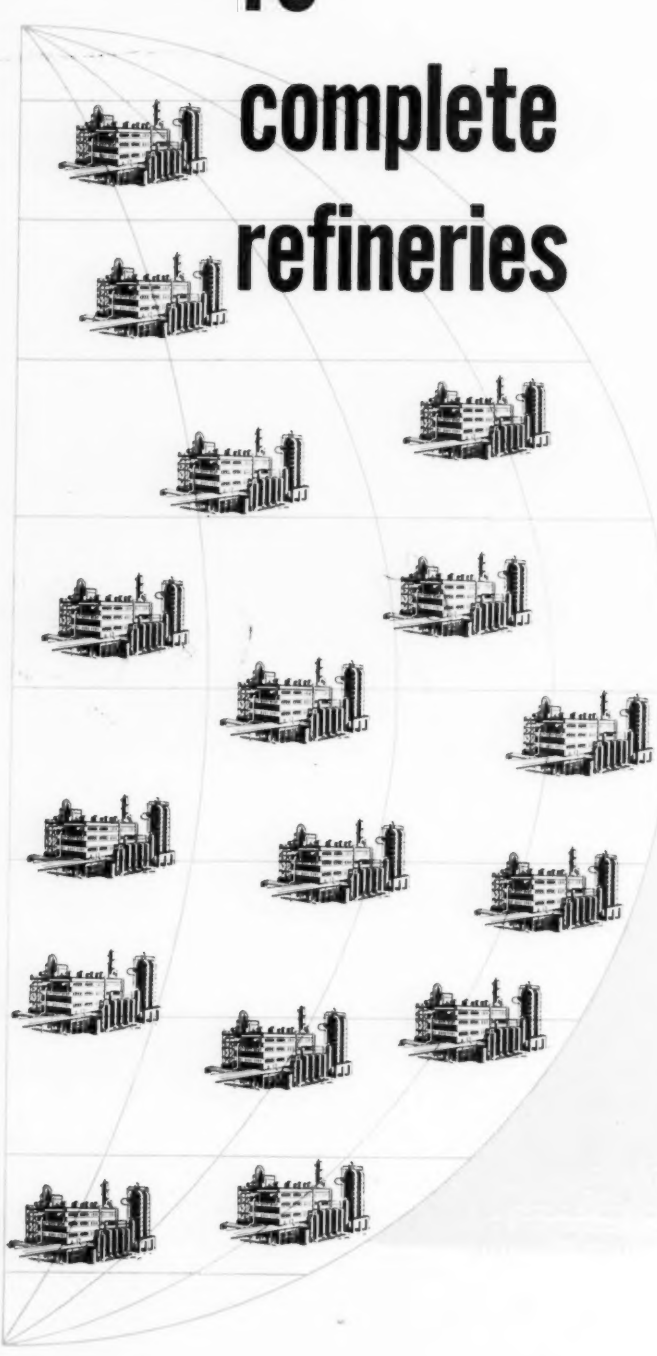
TECHNOLOGY REVIEW

TECHNOLOGY DEPT

February 1956

16 complete refineries



1945

1. Refinery for B. P. M. at Cardon, Venezuela.
2. Refinery for Koppartrans Oljeaktiebolag at Gothenburg, Sweden.
3. Refinery for Venezuela Gulf Refining Company at Puerto La Cruz, Venezuela.
4. Refinery for Societe Generale des Huiles de Petrole at Dunkirk, France.
5. "Portable" refinery for U. S. Navy Department.
6. Lube oil refinery for Cit-Con Oil Corporation at Lake Charles, Louisiana.
7. Refinery for International Refineries Inc. at Wrenshall, Minnesota.
8. Refinery for Vacuum Oil Company Ltd. at Coryton, England.
9. Refinery for Burmah-Shell Oil Company at Bombay, India.
10. Refinery for Standard-Vacuum Oil Company at Bombay, India.
11. Refinery for Standard Oil Company (Indiana) at Mandan, North Dakota.
12. Refinery for Suntide Refining Company at Corpus Christi, Texas.
13. Refinery for Commonwealth Refining Company at Ponce, Puerto Rico.
14. Refinery for Esso Standard Oil Company at Antwerp, Belgium.
15. Refinery for Caltex at Visakhapatnam, India.
16. Refinery for Neste Oy at Turku, Finland.

1955

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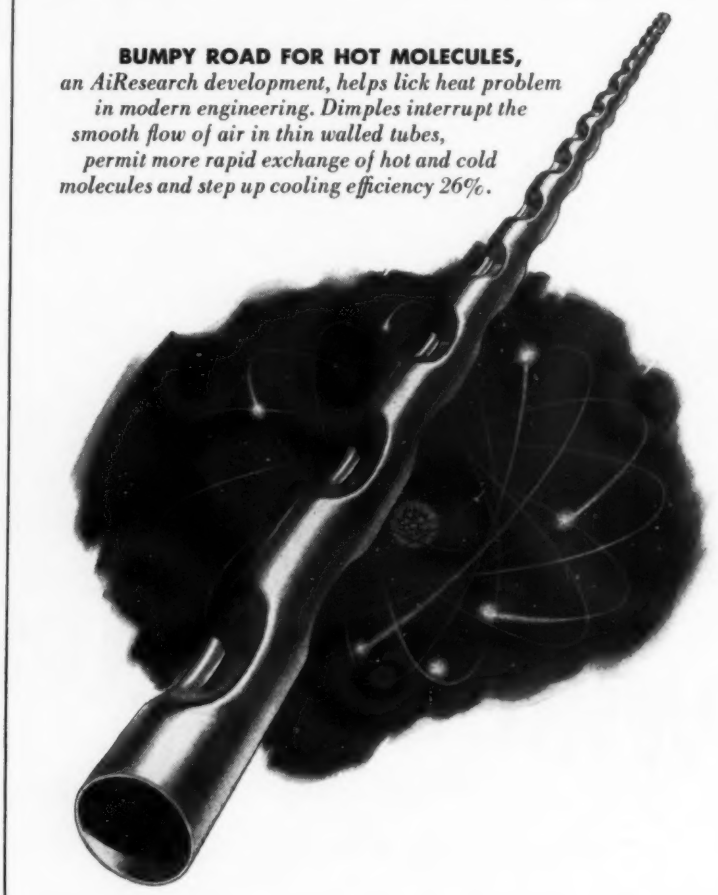
To the engineer who likes to blaze new trails...



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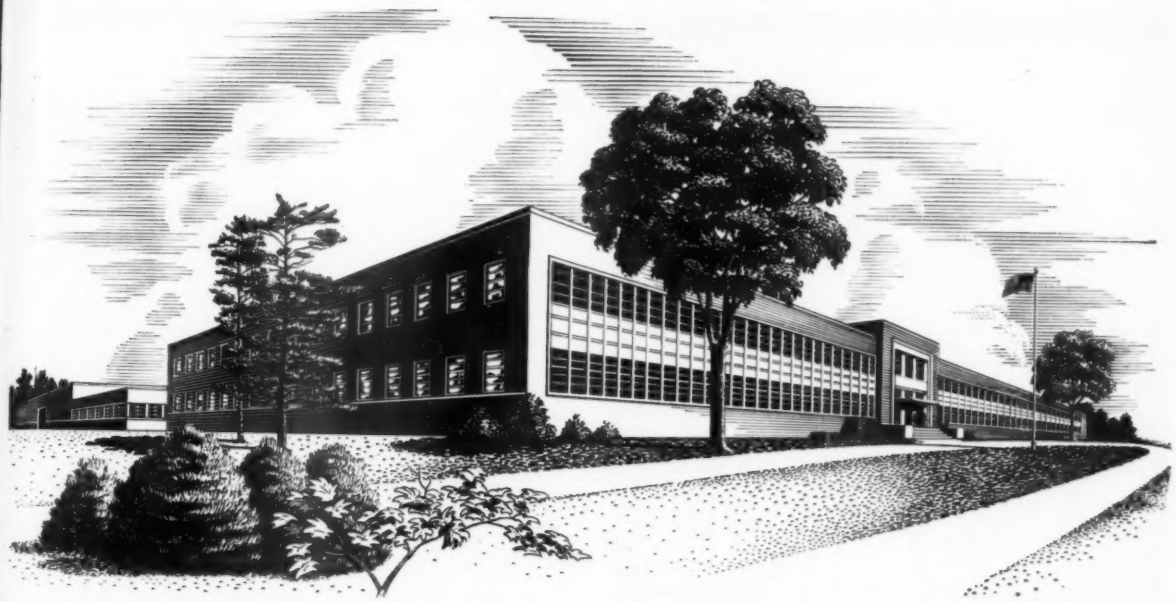

COMBUSTION ENGINEERING now building

NUCLEAR ENGINEERING AND DEVELOPMENT CENTER

On a 530-acre site in Windsor, Connecticut, Combustion Engineering is now building a Nuclear Engineering and Development Center. In addition to the Engineering and Administration Building, shown above, there will be a critical experiment facility for studying the physics and nuclear characteristics of reactor cores, a "hot" laboratory and a fuel element fabrication plant, together with related metallurgical, chemical and physical testing laboratories.

This multi-million dollar project, for which Stone & Webster Engineering Corporation are the architects and engineers, is scheduled for initial operation late this year and completion in early '57. In conjunction with new nuclear facilities recently placed in operation at the Company's Chattanooga, Tenn., plant, the Windsor plant will enable Combustion

to design, develop and manufacture complete nuclear power reactor systems

Heavy components such as reactor vessels, boilers, plugs and shields will be manufactured at Chattanooga. Reactor cores, including fuel elements and control rods, will be produced at Windsor.

The new nuclear building at Chattanooga includes such equipment as a 15,000,000-volt betatron for fast X-raying of thick plate and welds; large precision machine tools capable of handling work up to 20 feet in diameter with accuracies comparable to those required in watchmaking; and cranes to handle loads in excess of 300 tons. A new dock is equipped to handle reactor vessels too large and heavy for rail or highway shipment. By virtue of these facilities, Combustion becomes the *first company in the world* to possess equipment especially designed for the manufacture of heavy reactor components and to be able to ship them by water to virtually all river and coastal ports.

The panel at the right reveals the Company's current activity in the nuclear field. With the new facilities now available or in process, and others recently authorized, Combustion is prepared to achieve the same position of leadership in nuclear power that it has long occupied in the field of conventional power generation.

C-E NUCLEAR WORK 1955-56

Contract to design, develop and build complete nuclear reactor system for a submarine. *(This contract made Combustion the country's third major contractor to AEC on the naval reactor development program, and the first to undertake such a contract with its own facilities.)*

Contract to design and build major reactor components for U.S.S. Seawolf.

Contract to design and build major reactor components for large naval surface ship.

Contract to design and build major reactor components for Submarine Advanced Reactor and Submarine Fleet Reactor Systems.

Contract to design and build major reactor components for Shippingport plant to be operated by Duquesne Light Company. *(This will be country's first commercial size nuclear power plant.)*

Contract to design and build major reactor components for Atomic Power Development Associates. *(This fast breeder reactor, to be operated by Detroit Edison Company, is regarded as the most advanced type projected to date for a commercial size power installation.)*

Agreement with AEC for design and evaluation studies of both large and small reactors and of fuel elements and their fabrication.

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THE TABULAR VIEW

Technology and the Liberal Arts. — More than ever before, industrial leaders of the future will require general education which lends perspective, as well as specialized knowledge. In "Technology and the Liberal Arts" (page 187) HENRY B. DU PONT, '23, writes convincingly that one of the best ways of developing future leaders is through closer cooperation between industry and educational institutions. Mr. du Pont's long and intimate association with industrial and educational institutions lends a special force to his message. Mr. du Pont studied at Yale University and is a member of the Institute's Class of 1923. He was employed in the Engineering Department of the General Motors Corporation between 1924 and 1927, and since 1927 has been with the E. I. du Pont de Nemours Company of which he became a vice-president in 1939. Mr. du Pont is director of the North American Aviation Company, Wilmington Trust Company, and General Motors Corporation. He is president of the Alexis I. du Pont School in Wilmington.

Dollars from Wastes. — Growth of the nation's population, expansion of its urban sections, limited useful agricultural areas, and increasing demands for products made from dwindling natural re-

(*Concluded on page 178*)

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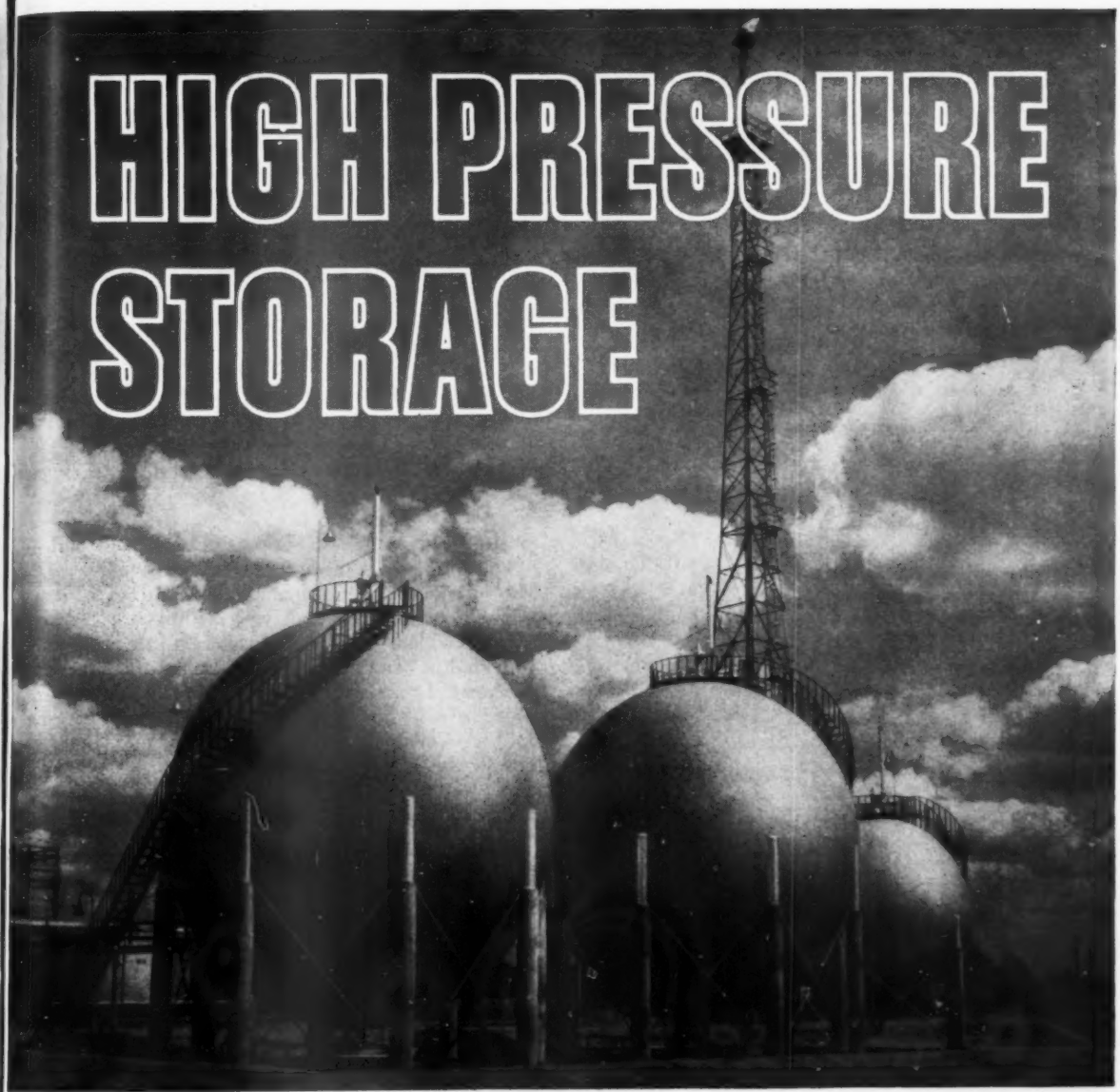

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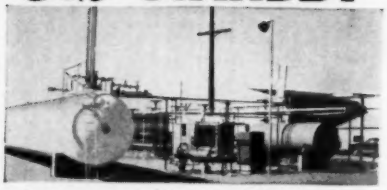

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THE TABULAR VIEW

(*Concluded from page 176*)

sources, all combine to pose a serious problem of conservation. One means of meeting expanding raw material requirements is to make more effective and efficient use of food and agricultural wastes, and "Dollars from Wastes" (page 191) by HARRY W. VON LOESECKE, urges the adoption of such a program. After graduation from Harvard University, Mr. von Loesecke became research chemist for the General Electric Company, the American Protein Corporation, and the United Fruit Company. He has also been senior chemist, industrial specialist, and technical adviser in a variety of projects related to agriculture and the food industry. Mr. von Loesecke is a fellow of the American Public Health Association, and member of the American Chemical Society.

American Engineering Education Abroad.— What problems confront the engineering professor who applies American methods in foreign lands where textbooks and laboratory facilities are less commonplace than here? One answer to this problem is provided in "Engineering Education at the American University of Beirut" (page 194) by EDWARD S. HOPE, '26 who has been professor of civil engineering in that university since 1951. Professor Hope received the B.A. degree from Morehouse College in 1923, the S.B. and S.M. degrees from M.I.T. in 1926 and 1927, respectively, and the Ed.D. degree from Columbia University in 1942. Following graduation from M.I.T., Dr. Hope spent a year as highway engineer for the State of New York, three years as hydraulic engineer in Rio de Janeiro, Brazil, and 12 years as superintendent of Buildings and Grounds, at Howard University. During his term in the Navy, between 1944 and1946, he became director of instruction, C.E.C. Navy Pacific University with rank of Lieutenant Commander.

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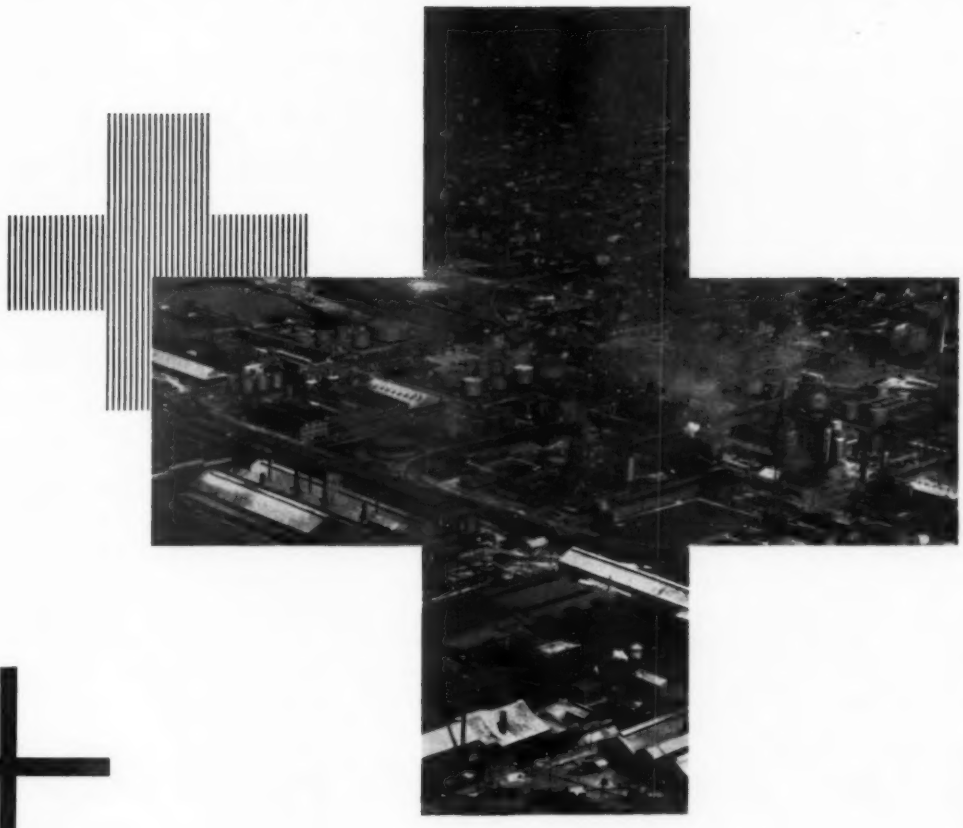

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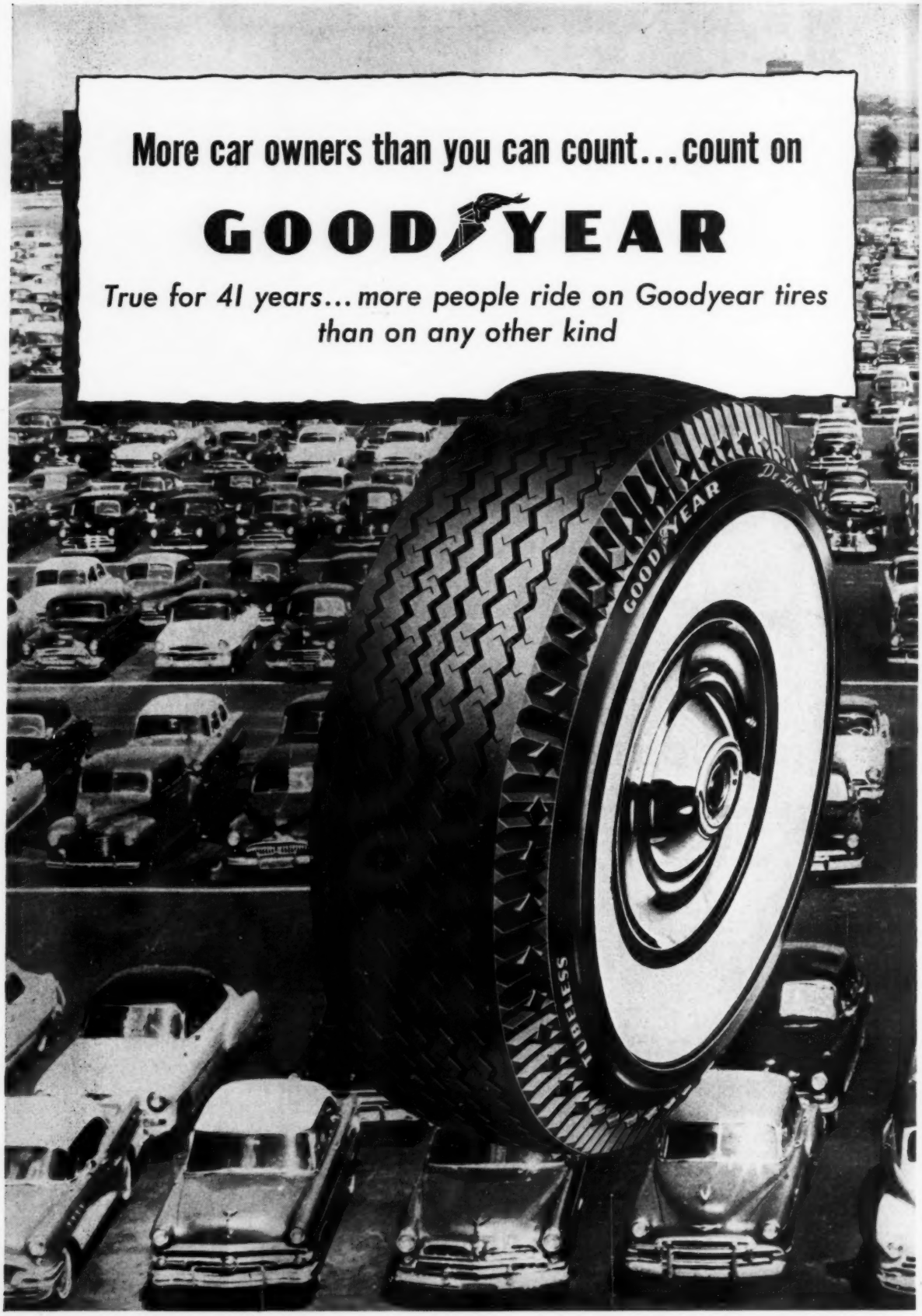
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Elliott B. Roberts, '21

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THE
TECHNOLOGY REVIEW

Vol. 58, No. 4 February, 1956

The Trend of Affairs

New Wine

THE flavors of foods and beverages, although everyday commonplaces, are actually dark mysteries. They cannot be gauged by objective scientific measurement, but only by the subjective judgments of the gourmet. As told in the pages of The Review* for December, 1950, flavor is a mixed experience including taste, odor, tactile, and other sensations, amenable to no objective chemical or physical test, but measurable only empirically. In the food and beverage industries flavor is judged by individual experts, or by trained juries, or by broad consumer tests with numerous participants. When multiple judgments are obtained, statistical procedures are employed to cancel out dullness of the senses, inattention, prejudice, and such human vagaries.

But aiming toward ultimate measurement of flavor in objective terms, the appalling task has now been bravely essayed of analyzing the flavor of one beverage in terms of constituents of known chemical composition. The beverage being so studied is one of venerable standing, known to all races – ancient and modern: wine. The food technologists who have undertaken to dissect the flavor of wine set out to answer questions such as these: What constituents of known chemical composition are responsible for the flavor? What is the lowest concentration of each flavor constituent apparent to the consumer (called "threshold value")? What differences in concentration are apparent? What effect does each flavor constituent have upon threshold value and perceptible concentration differences of every other one?

The elements of wine flavor were concluded to be 14 in number: alcohol, two sugars, glycerol, ethyl acetate, acetaldehyde, tannin, six organic acids, and sulfur dioxide. Threshold concentrations were found to vary widely. Thus the sugar dextrose was apparent to the taste only when present in concentrations of at least about one-half per cent; but acetaldehyde was tasted in concentration as low as .00015 per cent.

Perceptible concentration differences also varied widely for the various flavor elements; and for each varied according to the absolute concentration. Thus increments of about 1 per cent in alcohol concentrates could be detected by tasters in a dilute solution containing about 4 per cent alcohol. When about 16 per cent alcohol was present, increments could not be detected unless they were greater than 2 per cent.

As to interrelationships, alcohol was found to enhance the sweetness produced by sugars; thus 7 per cent sugar dissolved in 20 per cent alcohol was as sweet as 10 per cent sugar in pure water. Sugars dulled perception of differences in alcohol content, but acids diminished this effect of sugar in dulling perception to alcohol. Alcohol and acid both dulled perception of glycerol. Alcohol dulled the perception of acid; sugar did not affect the perception of acid, but did mask the flavor of tannin.

Now it remains to apply these interesting findings practically, so that perhaps certain major flavor characteristics of wines may be measured by quantitative chemical determination of certain of the 14 known major flavor constituents.

One incidental observation of this study is striking, especially since wine is dominated by the mumbo jumbo of the expert perhaps more than any other food or beverage. In extensive trials with the flavor elements of wine in pure form, it was found that experienced winetasters were no more perceptive of thresholds or concentration differences than inexperienced participants.

* Frederic W. Nordsiek, "All Experience Is of Change," The Technology Review, 53:87.

M.I.T. Photo

Science, the Mighty Multiplier

A DISTINGUISHED group of 1,500 Technology Alumni and other leaders in industry, education, and finance attended a dinner given by the M.I.T. Corporation at the Waldorf-Astoria Hotel in New York on Wednesday, January 4. The purpose of the meeting was twofold. It was the occasion of a tribute to Karl T. Compton, President of M.I.T. from 1930 to 1949, and chairman of the M.I.T. Corporation from 1949 until his death in June, 1954. It was also the occasion for the Institute's Corporation to report on the achievement of certain goals, and to express its appreciation for the magnificent support which the Institute has received in achieving new means for meeting its increasing needs and responsibilities.

In making his report on recent progress at M.I.T., James R. Killian, Jr., '26, President, announced that a School for Advanced Study had been established and will be under the direction of Martin J. Buerger, '24, chairman of the Faculty. The new School (opening in September, 1956) has been organized to give formal recognition to the importance of postdoctoral studies in advancing science and technology.

Tribute to the quarter century of leadership which Dr. Compton gave to M.I.T. was voiced by Robert E. Wilson '16, chairman of the Board of the Standard Oil Company of Indiana.

The third speaker was General Robert Cutler, chairman of the Board of Old Colony Trust Company, and consultant to the National Security Council, who spoke on the role of the National Security Council.

There is opportunity for only a brief news announcement in this issue of The Review and the illustration of distinguished guests seated on the dais. The March issue will contain a detailed report.

Blueprint to Milling Operations

IN the new manufacturing methods that are rapidly gaining acceptance, automatic machines and techniques capable of carrying out complicated processes without human intervention play a particularly significant role. One form of automatic machine, capable of producing complicated milled forms and whose operations are controlled by means of paper or magnetic tape input rather than by means of the usual model to be traced, gives promise of making a significant contribution to the evolution in automatic methods.

An automatic contour milling machine, having a cutting tool whose position is controlled by digital information from a punched record, rather than dimensions of a model, is a long step forward in automation. The time and effort needed to produce the tape by which the machine is controlled are considerable, however, and sometimes place a limit on the size of production runs which may be practical for automatic machine operation. More than that, the preparation of a suitable control tape may require knowledge of programming of a digital computer, which is not always possessed by those who would make most effective use of automatic machine tools. The production of the machine tool program involves a painstaking step-by-step analysis of machine operations, a determination of how the problem may best be treated by the machines, and the preparation of a set of instructions which, when obeyed by the machine, will effect the desired result. Many of the program operations are similar to those required to set up a problem on a large computing machine, and there is good reason to believe that such computing machines, which are coming to be more commonplace, could be used to prepare programs for automatic machines.

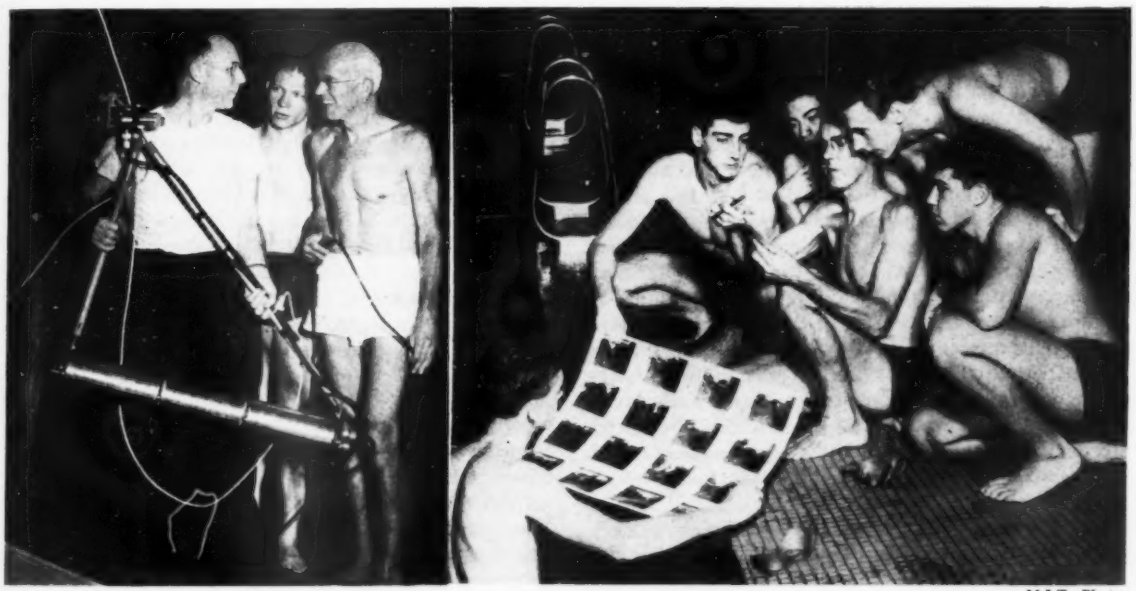
To be completely effective, any system for employing a digital computer in machine tool operations, must be easily used by persons familiar with machine tools and with metal-cutting processes, and should not require knowledge of, or extensive training in, digital computer operations. The nature of the calculations which may be involved can often be anticipated, and the computer can be coded once and for all, to handle calculations as they arise. The digital

computer can even be coded to determine what the needed calculations are.

Recent work in the Institute's Digital Computer Laboratory under the direction of Arnold Siegel, a research staff member of the Division of Industrial Coöperation, has been directed toward the development of a technique for adapting digital computers to the programming of automatic numerically controlled machine tools. The purpose of this research is to develop methods by which designers familiar with machine tool operations can specify the necessary cutting operations in terms of points, lines, circles, or similar information that can be derived directly from engineering drawings of the part to be milled. The machine operator or designer can then specify cutting speeds and the direction of the cutting tool in three dimensions in terms of design data. Once this information is available, digital computers can convert it into the necessary punched-tape code for controlling operations of the milling machine numerical control system.

Of course, the user of the automatic machine must be able to present his problem to the computer for solution. This is accomplished by providing him with an input "language" which can be mastered in a few minutes. A simple and readily learned vocabulary has been devised by means of which the designer establishes the required cutting operations. The vocabulary is one which it is possible to implement on the Whirlwind I computer or other high-speed digital computer. The required terminology is based upon plain English and simple symbols which are, in turn, related to the dimensions and cutting operations which the machine tool must effect. The input language is primarily designed to specify the required milling operations in terms of the data which would be given in the majority of typical engineering drawings and blueprints.

It is considered that such a program will be very useful to the M.I.T. Servomechanisms Laboratory and will represent a forward step in the application of digital computers to automatic control processes.



M.I.T. Photos

(Left) *Professor Harold E. Edgerton, '27, of the Department of Electrical Engineering, and Gordon H. Smith, swimming coach, discuss the underwater camera used to study M.I.T. swimmers. At the right, Coach Smith and some of his swimming enthusiasts study the results of underwater photographs showing the students in action in the Alumni Pool.*

Electronics Aids Tech Swimmers

PHOTOGRAPHY, aided by electronic flash equipment, is being employed to help train students at M.I.T. who go out for swimming. Gordon H. Smith, swimming coach, finds the technique especially useful in developing, in his swimmers, the ability to make turns properly. A series of still photographs are taken which show the position of the swimmer as he reverses his direction at the edge of the pool.

Coach Smith operates the underwater camera from the surface, timing the moment of exposure by a manually operated push button. The camera uses 100-foot lengths of 35 millimeter film, and 800 separate exposures can be made from a single loading of the camera. Power for winding the film and for synchronized electronic flash is obtained from the usual 115 volt, 60-cycle circuit. The equipment is designed so that a complete cycle of operation requires only about five seconds.

The camera used for this purpose is one of the underwater types developed by Harold E. Edgerton, '27, Professor of Electrical Measurements at the Institute. Several of these cameras were used on expeditions of the National Geographic Society, and particularly in cruises of the *Calypso* under the command of Commandant Jacques Y. Cousteau. Recently photographs with such equipment were made some 14,000 feet below the surface at the deepest area in the Mediterranean Sea, fairly near Cape Matapan in Greece. No M.I.T. swimmers were found at this depth, however.

Microbe Measurements

THE biological sciences in general have lagged far behind the chemical and physical sciences in quantification techniques — or as scientists are apt to say with reckless disregard of etymology — "quantitation" techniques. Thus, compare quantitative analytical chemistry with quantitative bacteriology.

Highly exact methods for quantitative chemical analysis, both gravimetric and volumetric procedures, have long been known. In recent times even more precise methods, capable of measuring increasingly minute concentrations, have come through paper chromatography, electrophoresis, infrared spectrophotometry, and ultracentrifugation.

But only rough methods have been available for a basic procedure in quantitative bacteriology, the determination of how many bacteria, yeasts, molds, or other micro-organisms are present in a sample. Such procedures are required in food technology, the fermentation industries, the sanitary control of drinking water supplies, and clinical medicine, where it is frequently important to know not only the types of micro-organisms present, but also the concentration in which they occur. The classic method for determining microbial concentrations, called "plate counting," is rather crude, and has remained essentially unchanged since the days of Pasteur. The plate count involves essentially the mixing of a measured quantity of the unkown into a sterile nutrient jelly in a sterile glass dish, then holding this dish in a warm incubator several days, thus allowing each microbe present to develop into a colony visible to the naked eye. These colonies are counted, and their number considered to be equivalent to the number of micro-organisms present in the sample. The procedure is laborious, slow, and inaccurate. It is applicable to only a limited range of bacterial concentrations; substances heavily laden with bacteria may be counted by diluting them with sterile water, but the method is quite useless with samples of very low bacterial concentrations.

There are also direct methods for counting bacteria, essentially the spreading of a known quantity of the sample on a known area of glass slide, staining this preparation so that the microbes become visible, then counting representative fields under a microscope calibrated so that the area of the slide covered by each field seen through the ocular is known. Such methods are limited to fluids having high bacterial levels, such as raw milk, and have the great disadvantage that they do not distinguish living micro-organisms from dead ones.

Crudest of all methods for gauging bacterial concentration are indirect estimates based on some effect produced by the micro-organisms. Thus in the sanitary analysis of drinking water, samples are customarily added to sterile nutrient broth containing lactose. Generation of gas from this brew is considered presumptive evidence of fecal bacteria; and the quantity of gas, the speed with which it appears, and the amount of the sample required for gas production are interpreted as measures of the concentration of fecal bacteria present.

But quantitative bacteriology has now taken a significant stride forward with development of a device generally known as the "membrane filter." These appear to be paper discs about one and three-quarters inches in diameter, but actually are made of cellulose esters and, quite different from paper, have pores measuring less than one micron in diameter. Hence these filters retain most common bacteria, yeasts, and other micro-organisms, which generally have diameters somewhat greater than one micron. But the pores of the membrane filter are numerous, numbering over 50,000,000 per square centimeter; hence liquids and gases pass through them freely.

Membrane filters have today gained wide use in quantitative bacteriology of liquids or gases. The unknown is passed through a sterile filter; all of the microbes present are caught on the surface of the disc. It may then be immersed in a dye which stains the micro-organisms so that they can be counted directly under the microscope. Or it can be saturated with a nutrient fluid and incubated, whereupon the microbes grow into colonies that may be counted under low magnification.

The membrane filter method of counting bacteria has been found to be quicker, more convenient, and more accurate than the conventional plate-counting method. It is applicable to gases; the standard plate count is not. The membrane filter may be applied to samples with very low bacterial content, as any volume of unknown may be passed through the filter and all microbes present are caught. When laboratories are not readily accessible, bacteria from samples may be collected on a membrane filter in the field, and the filter held in a preservative for long periods of time awaiting subsequent examination.

Filters fine enough to catch bacteria are not new, but in the past have been limited to expensive, cumbersome, slow devices such as ceramic cylinders. Such filters were used mainly to sterilize fluids without exposure to heat. The membrane filter is equally useful in such applications. It is now used for the sterilization by filtration of pharmaceutical products, wines, and beers. Still other biological applications of the membrane filter are in removal of pyrogens* from injection solutions, and in zoological studies of marine micro-organisms. This filter is also used for chemical studies such as the separation of insoluble matter from water, collection of small colloidal particles and air-borne dusts, and assays of acid mists, metal fumes, and smokes. Apparently chemistry, as well as biology, has acquired a useful new tool in the membrane filter.

Exercise Symposium

THE importance of exercise to bodily health, a subject of increasing personal interest and intensified professional study, was discussed at the Institute on January 10, in a special symposium for doctors, physical education directors, and athletic officers of New England colleges.

The symposium, entitled "The Physiological Effects of Exercise vs. Inactivity," was sponsored by the Coaches' Association and the Medical Department of M.I.T., and was held in the Institute's Kresge Auditorium.

* See "Fever Makers," The Technology Review, 47:357 (April, 1945).

Technology and the Liberal Arts

Closer Co-operation between Industry and Education

Seen as Best Way of Developing Leaders Possessing

Perspective as Well as Specialized Knowledge

By HENRY B. DU PONT

THE other day, I ran across a statement someone had made which was represented to be the Communist party line on the relationship of industry to education. I have been in industry for many years and have had a hand in education for some time as a college and school trustee, so I was interested immediately and will pass this comment on to you. It was stated that the American educational system and American industrial institutions are so closely allied that they are really parts of the same thing; namely, of what is sometimes called the "economy of capital." The American university, it is charged, actually has a vested interest in the economy and is, therefore, likely to favor its successful continuation! It struck me as somewhat odd that a condition which the Communists believe to be such a weakness can be regarded here as one of great strength!

There should be no argument over the community of interest between education and industry, for their mutual interdependence is quite obvious. Both are essential parts of the American economic system. Each prospers in proportion to the health of the economic order, and each has an enormous stake in the well-being of the other.

Whatever construction the Communists or others might put on this common interest, there can be little doubt that the results, as measured in terms of public benefits, have been remarkable. We have, in the United States, an educational system that is second to none in the world. We have an industrial establishment that has learned to perform technical and production miracles. And each has been able to do something that no educational system and no industrial system has ever done before in world history – it has brought its product, whether it be a diploma or a deepfreeze, within the reach of practically every family.

This is a noble objective and the degree of achievement has been notable. Each of us, I think, can be proud of this accomplishment and proud of his own contribution. It shows what can be done under a democracy through the co-ordination of our resources, both human and physical.

Our success in meeting jointly the needs of this mass market, in education and in consumer goods, results from the fact that we have created, between us, a great new force, a force which has given new meaning and new dimensions to the multiplication table. Where one man working one hour once produced five bushels, or pounds, or dozens, this new force now multiplies that hour's output to 10 or 15 or 20. It is a force bringing together machinery and equipment, skills and techniques, men, money, and methods. It is one of the most powerful forces in the world today, a force that transforms men into giants, deserts into gardens, and poverty into wealth. It is the force we call technology.

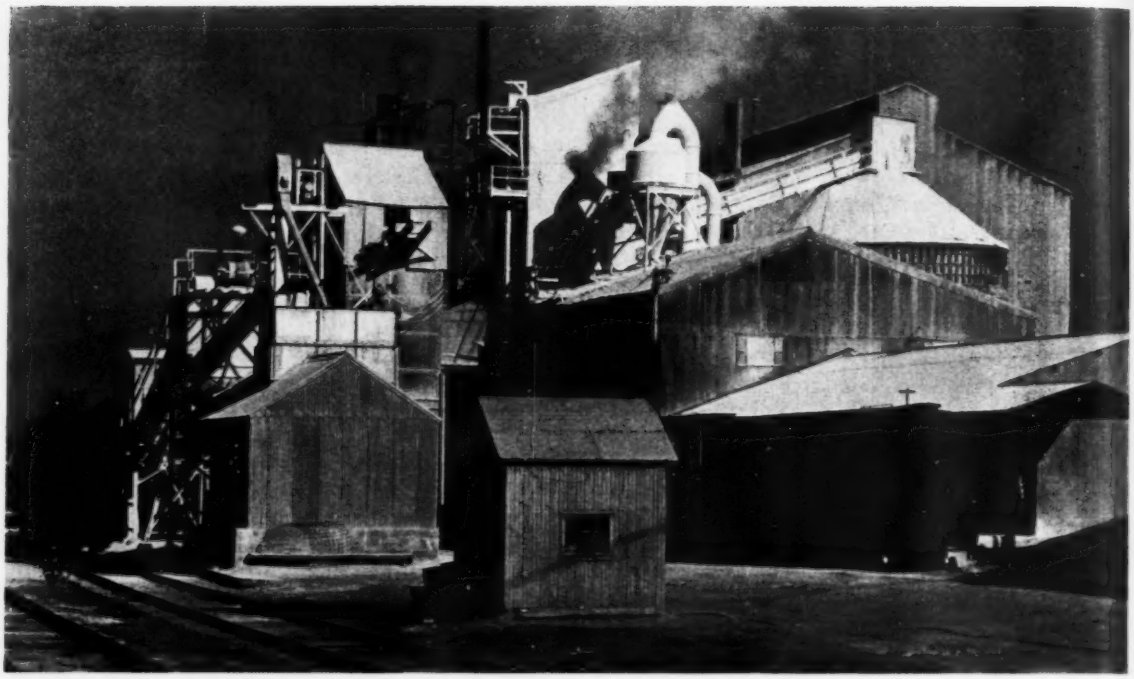
Technology actually begins and derives its greatest strength in the universities, for its most dynamic fuel is the flow of human initiative and human imagination shaped and developed in the careful training of human minds. And technology becomes reality in American industry when the diverse components of money, man power, and management are brought together and the great force is harnessed to the needs of humanity.

The leverage of our technology has brought benefits to everyone regardless of his profession. Its effect upon our daily lives in terms of conveniences, comforts, and security is so taken for granted that we become aware of it only when, in some crisis or emergency, we are temporarily deprived, as when the oil burner breaks down on a cold night or when the hurricanes that used to stay in Florida disrupt our communication lines.

Other effects of technology upon the social, political, and economic patterns of life everywhere have been profound, more so than many yet realize. It is the most significant factor in the rise and fall of nations. And nowhere has its influence been felt more importantly than in the halls of learning.

Two great revolutions have taken place in the field of education in the last half century – one cultural and one social. Each has resulted from the impact of expanding technology and industrial advancement.

The first great change has been the transformation of the American college from a liberal arts sanctuary to one in which technical training in engineering and the physical sciences have come to have so important a place. In 1900, out of an enrollment of approximately 225,000 college students, something less than 11,000 were being trained in technical fields, or about 5 per cent. Today, more than 15 per cent of all college students are in engineering alone, with a very large number additionally in the various basic sciences. This upswing is reflected further in substantial expenditures in the interest of providing technical training by American universities in the past 50



Lime kilns, photographed by Aaron G. Fryer from Black Star, are expressive of America's technology.

TECHNOLOGY AND

years. It is a far different situation than that which prevailed in the earliest days of American education, when more than half of all college graduates were trained for the ministry.

The second great change to be observed concerns the greatly enlarged percentage of the population which attends college. In 1900, about one boy in 30 went to college. Today, it is one boy or girl out of three, and the probabilities are that this ratio will increase. We are undergoing the greatest mass educational program in history and on a scale which, by standards set in other parts of the world, is fantastic. For example, Communists everywhere have made much of the state of the American Negro. Despite the conditions which are so often alleged, there were more Negro students graduated from American colleges this year than there were graduates of all kinds from colleges in Great Britain – from a population of 15,000,000 American Negroes and 50,000,000 Britons. We had as many college students in 1950 as we had high school students in 1920.

I think it is safe to say that we are now reaching the point where no boy or girl of adequate intelligence who is willing to spend the time and effort need lack for a college education.

As we study the first of the two great changes in education, we see that the effect of technology on the curricula and the character of our institutions of higher learning have been enormous and far-reaching. I think it is probably true that, in recent years, this change resulted in an apparent overemphasis on technical education. There was a time, perhaps it is still with us, when those in the field of the liberal arts and the humanities saw perils in the rapid development of the technical schools. They were somewhat awed by the large funds which were poured into the universities for physical plant, scholarships, and budget requirements of the engineering and scientific facilities, particularly when it appeared that this was done at the expense of the liberal arts side of the campus. This was quite a natural feeling, but I think we have, by now, come to realize that there is actually no basis for conflict; that each branch of education – technical and cultural – depends in an important way upon the other.

It is, of course, ridiculous to assume that there should be any real incompatibility between technology or industrial development and the scholarly pursuit of learning. The growth of the American university system has paralleled our industrial growth. In addition, much of our cultural development, particularly that which brought cultural opportunities to millions of people, has come through endowments by men who shared the rewards of industrial enterprise with the general public. Art galleries, libraries, museums, historic restorations, public parks and gardens, and many other such institutions offer testimony today to the benefactions of men who were successful in the business and industrial field. Without enterprise and its successful operation, there would obviously have been no rewards to share.

I think it can be said that, as patrons of the arts, American business and American businessmen have made contributions that might have been impressive to Lorenzo the Magnificent. For this patronage did not stop with gifts and bequests for artistic purposes; more importantly it represents the creation of a society which has leisure to enjoy a cultural heritage.

If the arts, the social sciences, and the humanities were ever in danger of being de-emphasized, the

critical period has passed. In my opinion, the liberal arts are on the threshold of their most useful period of expression, for our need today is for education in its broadest sense. That is the area in which it should become clear that the liberal arts, which form the basis of all education, have lost none of their former luster.

Historically, it is to the universities that we look for the training of succeeding generations. The task before all of us today in planning for the future is particularly difficult, and the university's part is especially important at this time. Our society demands that the universities supply us not only the trained technicians and the gifted specialists as such, but those with a potential for broad leadership. The greatest need, now more than ever before, is for leaders – leaders with intellectual honesty, with objectivity, and with purpose.

These are fast-moving and often confusing times. The sights and sounds that confront us are frequently disturbing. The new leaders that must emerge to face the challenge of this strange new world will have problems much different from those of their fathers' and grandfathers' time. Leadership is never an easy role, of course, but the kind we need today is vastly different from that required in earlier days. It has not been so long ago, for example, that the very fact of having an education, by its rarity, was some qualification for leadership. In some parts of the world even today, some degree of eminence is held simply by those who are able to read and write.

But what about leadership in a country where more and more of us are – at least nominally – the proud possessors of a higher education? What new responsibility must be fulfilled?

The new leadership calls, it seems to me, more than anything else for perspective. Perspective is what the eye gives us when we climb up high and take a long-range look at the landscape – we see objects which we could not see at all close at hand, and some which seem quite different from our first impression. We orient each into its relative position with respect to other objects and to the picture as a whole. When a scene is simple and uncomplicated, there is less need for the view from the crow's nest, but when the scene is crowded and diffused and alive with puzzling and sometimes inconsistent movements, the more perspective we can give it the better.

So it is today with this highly complex and technical society in which we live. The more complex it becomes, the more the individual needs to specialize and to narrow the focus of his own effort. Yet the greater degree of specialization we achieve, the greater the need for perspective that can balance and equate the diverse elements in terms of the broader purpose.

The technical student of 50 years ago could hardly have seen, in his simple experiments, the kind of social and political forces which now exert pressures upon our society – many, if not all of them, arising from the changes brought about by advancing technology. The technical student of today, in contrast, must recognize and understand these forces exerted by labor, by government, by the courts, or by public opinion just as he must understand the stresses and strains of physical phenomena. Otherwise, his capacity to provide the proper kind of leadership will be severely limited.

The liberal arts curricula of 50 years ago, with the emphasis directed properly on the classics, could

THE LIBERAL ARTS

Annual art exhibit in New York's Washington Square, as photographed by Ward Allan Howe.

scarcely have anticipated that our technology in a few years would revise all previous estimates of human progress. They could hardly have foreseen that old and well-accepted doctrines like the Iron Law of Wages, or the Limited Market, would collapse under our great outburst of productivity and invention. The liberal arts courses of today, if they are to be described either as liberal or as arts, must include a thorough analysis of the impact and the meaning of technology. Students should come to recognize not only the vital part technology has had in human improvement, but the conditions essential to its survival – the capital requirements, the incentives, and the environment in which it can operate to the best advantage.

It would seem odd that there should be any controversy about so plain or so significant a force as technology, yet it is obvious that misunderstandings do exist. Failure to understand the nature of technology is the basis of many of our present national and international tensions. Misunderstanding represents a threat to our military security and our economic growth, each of which depends on our technical development. It is at the root of much labor-management dissension. Political discussions on questions of taxation, tariffs, monopoly, and even of defense often betray a tendency to what we might call optical delusion – failure to see the other side.

The danger is that we tend to look at life not as through a window, but through a mirror. And we are likely to see only the image of ourselves rather than the clear and undistorted truths that lie just beyond. Mirror-thinking is giving us too much of our own and not enough of the other fellow's point of view. What we must have is an exchange of viewpoints to give us the whole picture.

The role of leadership in tomorrow's world will be assumed neither by those who know a great deal about a very little or a very little about a great deal. It will be discharged only by those whose thinking is broad and uninhibited, those with grasp and understanding – leaders, in short, whose horizons are wide enough to comprehend the world in which we live.

This, of course, is the basic objective of the liberal arts as it is the basic objective of all education. Here we have the truly educated man, well equipped to comprehend fully the world he lives in. This is the prime goal of all education, just as it is the prime criterion of all leadership.

Industry is well aware of the fact that its progress depends very importantly upon the character and caliber of those who will become its leaders in the future. Any industrial concern or any responsible industrial official will list as the Number 1 problem the ever-threatening shortage of both technical and management talent for the future. This kind of talent needs long and careful training in the universities under careful and expert guidance from faculty and administration.

Industry is well aware also that such a program is a highly expensive undertaking. I think it can be said, further, that industry is well aware of the present financial difficulties faced by many, if not most, of our colleges and universities and of the even more critical problem of providing adequate facilities for the future.

So much has been said recently about the troubles of the American educational system that we are likely to minimize and underestimate its remarkable strength. The educational system is one of the greatest, perhaps the greatest, of our national resources, and certainly it represents collectively one of the largest enterprises ever undertaken. In units, it is made up of more than a quarter of a million elementary and secondary schools, nearly a thousand colleges and universities, some 500 junior colleges, and over 250 teachers' colleges or normal schools. Total assets in educational property alone are something over 15 billion dollars which, I am told, exceeds the national wealth of most nations; only six countries in the world, in fact, have a total wealth exceeding that represented in the American educational investment. Annual expenditures for public education are now something like four billion dollars, or as much as we spent for our entire government expense not so long ago. The total endowment in colleges and universities exceeds two and a half billion dollars. In our teaching profession, we have a dedicated group of more than 1,000,000 men and women who are giving us increasingly high standards. Make no mistake about it – our educational system is on a firm foundation and its future rests on a very strong base.

Despite these impressive assets, the needs are very great. In the universities, we must cope with rising costs, greatly increased enrollments and, I am afraid, diminishing prospects of capital funds from former sources. And, despite my assurances that industry shares your concern over these problems, I can offer no neat solutions. It does seem to me that there are three possible sources of relief for the most urgent needs, all of which must be considered.

The first and most obvious, of course, is a continuation and increase in the help given to universities by corporations and foundations. Corporations must and will give generously, if only as a matter of lively self-interest. Last year, our company contributed about $800,000 in support of higher education, and it is estimated that the American industrial establishment is now contributing more than $100,000,000 a year to the support of various universities. Increasing percentages of this should, in my opinion, be committed in one way or another to the liberal arts institutions. I think it probable that the amount contributed by industry might well be doubled over the next 10 years, but, as you well know, even if it were, it would account for only a small portion of the annual need.

A second possibility of financial relief is more long range in nature. For the capital needs of higher education, universities face the sober fact that large gifts and bequests which built much of the present American university plant will probably provide less and less in the future. In the 50 years between 1880 and 1930, private gifts to education amounted to more than two billion dollars, or, in terms of present costs, almost five billion dollars. The ability of people to accumulate funds for such wide-scale philanthropy has now been curtailed by current tax philosophy. If

(Continued on page 214)

Dollars from Wastes

Food and Other Agricultural Waste Can Supply Many Raw Materials for Manufacturing Products Now Made from Our Dwindling Natural Resources

By HARRY W. von LOESECKE

About 550 billion pounds of food are produced annually in the United States for feeding our population. Before reaching the consumer, practically all of this food is processed in some manner during which there results an enormous volume of waste, both solid and liquid. Table 1 gives an estimate of solid wastes created by processing certain fruits and vegetables, and amounting close to 10 million tons annually. This figure will, of course, vary according to the quantity of fruits and vegetables processed each year. This quantity of waste is equivalent to the garbage of 85 per cent of the population of the United States, which each year must dispose of an additional 12 million tons accumulating in the home preparation of food. In addition to processing wastes of fruits and vegetables given in Table 1, there are field wastes brought about in preparing fresh fruits and vegetables for the market. These wastes probably amount to some 2.5 million pounds annually. There are further wastes created in meat slaughtering operations, sugar making, grain milling, alcoholic beverage manufacture, poultry processing, soluble coffee production and processing dairy products.

The housewife disposes of her garbage by burying or burning it, or through municipal collections. In general, the food processor must take care of his own wastes, and in many instances has turned these materials into dollars.

Most food processors find that disposal of liquid wastes resulting from washing, blanching, and clean-up operations are the most difficult and expensive disposal problems. Turning these wastes into dollars appears to hold little hope because the waste products are generally too dilute for the economic recovery of materials of value. In isolated cases, liquid wastes have been used for irrigation.

Citrus processing wastes have become of increasing importance during the past two decades. Whereas in 1930 only about 9 per cent of the citrus crop in the United States was used for processing, today close to two-thirds of the crop goes into processed products, creating some five million tons of solid wastes. Of this amount, about 4.5 million tons are dried for cattle feed with a value of about 13 million dollars; 100,000 tons are used for pectin manufacture worth some 20 million dollars, and from 600 to 1,000 tons are utilized for brining, candying and marmalade manufacture.

In disposing of one waste, it sometimes happens that another is created. This occurred in the uitilization of citrus wastes for cattle feed. In processing the waste, many plants press the material to decrease the water content so that less moisture will have to be removed in the driers. Mechanical removal of water is less expensive than removal by evaporation. The press liquor obtained in this operation, amounting to about 7,000 gallons for every ton of dry feed produced, contains on the average 10 per cent solids, and cannot readily be disposed of without danger of creating public health nuisances. The material is therefore evaporated to yield a molasses which may either be added back to the dry feed, or sold to mixed feed manufacturers. Approximately 50,000 tons of such molasses is produced annually.

Citrus oils, such as lemon, orange, and grapefruit are also obtained from citrus waste. Such oils, whose

TABLE 1

Estimation of Amount of Waste Created Annually in the Processing of Certain Fruits and Vegetables

Commodity	*Nature of Waste*	*Estimated Amount (Tons)*
	Vegetables	
Asparagus	Butts	45,000
Beans, lima	Vines and pods	80,000
Beans, snap	Snips and culls	30,000
Broccoli	Trimmings	12,000
Beets	Trimmings	35,000
Cabbage	Trimmings	40,000
Carrots	Trimmings	20,000
Corn, sweet	Husks and cobs	1,300,000
Cucumbers	Culls	30,000
Lettuce	Trimmings	345,000
Peas	Vines and pods	1,300,000
Spinach	Trimmings	50,000
Tomatoes	Skins, cores, culls	900,000
Total Vegetables		4,187,000
	Fruits	
Apples	Peels and cores	215,000
Apricots	Pits	60,000
Cherries, sour	Pits	15,000
Citrus	Peels, rag, seeds	5,000,000
Peaches	Pits and peels	270,000
Pears	Peels and cores	145,000
Plums	Pits	1,500
Total Fruits		5,706,500

Total for Fruits and Vegetables – 9,893,500 *Tons*

California Fruit Growers Exchange

Draining pectin obtained from waste citrus peel. Some five million pounds of citrus pectin are produced annually to be used in making preserves and confectionery.

total production has been estimated to have a market value of some six to eight million dollars annually, find extensive use as flavoring materials in confections, dessert powders, cookies, cakes, extracts, and soft drinks.

Of importance, too, is the recovery of certain flavonoids from citrus wastes, a venture stimulated in 1936 by reports of the vitamin-like (vitamin P) activity of water extracts from lemon peels. While so-called vitamin P has lost favor as a vitamin, reports continue to suggest that it may have some important pharmacological properties. There has therefore been a rather steady production of flavonoids from citrus wastes. Hesperidin is produced from orange peels and has certain therapeutic properties, naringin, a flavanone glycoside, is extracted from grapefruit peel, and is used commercially to impart a bitter flavor to beverages, confections, and to marmalades made from sweet oranges. Naringin has no known therapeutic properties. Although production of these two compounds is not great, they are high-priced commodities.

Apple wastes, created in the preparation of apple juice, vinegar, preserves, and other apple products, amount to around 215,000 tons annually. Such wastes are dried and used either for cattle feed, insect baits, or for preparing pectin; production of the latter amounts to about a million pounds a year. Pear cannery waste is converted into livestock feeds by an inexpensive chemical treatment and a special type press, a procedure developed by scientists of the United States Department of Agriculture. Of the estimated 145,000 tons of pear waste occurring annually in the United States, about 50,000 tons are produced alone in the San Jose area of California. These 50,000 tons will yield about 4,700 tons of pear molasses and 4,500 tons of dry pulp, with a value of from $200,000 to $300,000.

Apricot and peach pits, accumulating in canning, freezing, and drying operations, are crushed between steel rolls to remove the kernels which are used for the preparation of both a fatty oil and a flavoring oil. The refined fatty oil may be used as an edible oil, in pharmaceuticals, and in cosmetics. Apricot pits are utilized for the preparation of bitter almond oil, the raw material being the press cake after expressing the fatty oil. Practically all of the macaroon paste used by bakers is made from apricot kernels.

In the making of wine, about 110,000 tons of pomace, lees, and argols are obtained annually. This waste material contains approximately 5,000 tons of tartrates with a value of some four million dollars. Only about 50 per cent of the tartrates present in the wastes are being recovered, chiefly because of the lower price of imported tartrates. Tartaric acid and tartrates are extensively used in foods, in silvering mirrors, in textile printing and dyeing, in photography, and in the leather industry.

Peas and corn lead all vegetables in the tonnage of waste produced. Pea waste is largely in the form of vines which may be stacked in open stacks containing up to 2,000 tons of vines, adjacent to the viners at the processing plants. The stacked vines undergo a curing process similar to that obtained in a silo. The cured material is used as a cattle feed, offering a small return to the processor. Leafy vegetable wastes, rich in proteins, minerals and vitamins, are sometimes dried and converted into meal for livestock and poultry, and for the extraction of chlorophyll and carotene (provitamin A). Another product of this extraction is xanthophyll, used in poultry feeds to give a yellow color in the skin and shanks of poultry, thus increasing consumer demand.

Some 900,000 tons of tomato waste are available yearly. This waste, after pressing, is dried and sold for feed, representing a value of nearly $3,000,000.

An estimated 1.3 million tons of cobs and husks result from the processing of sweet corn. To this amount must be added about 15 million tons of cobs made available from shelling operations on farms, at country elevators, seed plants, and at some corn-milling plants. Approximately one million tons of these cobs (worth some 10 million dollars) are used annually in cattle feed, for poultry litter and mulch, as an abrasive in finishing metal parts, for molded plastics, hard rubber goods and glass products; in air-blast methods of cleaning, as an abrasive in hand soaps, for cleaning and dressing furs, and as a raw material for the production of furfural. Furfural, with an annual production of about 50,000 tons, finds use as an organic solvent, in the manufacture of certain plastics, in Nylon production, refining Diesel oils, and as the raw material in the preparation of certain antimalarial drugs.

Every year about 500,000 tons of wheat straw, left in the field by the combine harvester, are used for preparing corrugating paper, the basic material for the indispensable shipping container and other strawboard products. Wheat farmers profit by the utilization of this waste product by an estimated three million dollars annually. Sugar-cane bagasse, a by-product of the sugar mill where juice is extracted from the cane, accumulates at the mill. Annual production of bagasse in the United States amounts to about two million tons. Some of this is burned under the boilers

at the mill to furnish power for sugar production with a resulting savings in the fuel bill. Wet bagasse has a fuel value of from 3,294 to 6,716 British thermal units per ton, compared with about 150,000 Btu per gallon for fuel oil. About 500,000 tons of bagasse are used for the manufacture of insulating and wallboard. Because of the short fibers in bagasse, pulp made from this material must be mixed with regular sulfite pulp to obtain a paper of the desired strength.

Long considered a nuisance in the processing of sugar-cane juices because it fouled evaporators, aconitic acid is now recovered from molasses by a process pioneered by U.S. Department of Agriculture scientists. Louisiana molasses contains from 0.1 to 0.2 per cent aconitic acid, more than molasses produced in Florida. The reason for this is not clear, but is thought to have something to do with the length of the growing season in Louisiana. Available aconitic acid from the Louisiana cane crop amounts to about 15 million pounds annually, but only about 10 million pounds could be recovered feasibly by present methods. Actual production is estimated at one to two million pounds a year with a value of from $150,000 to $300,000. The acid is recovered as dicalcium magnesium aconitate, and is used chiefly in the production of high molecular weight esters used as plasticizers.

Of particular interest in turning wastes into dollars is the utilization of certain waste waters from sugar beet factories for the preparation of monosodium glutamate, production of which has an annual value of over 13 million dollars. This product, the sodium salt of glutamic acid (an amino acid), is sold under such trade names as "MSG," "Accent," and "Zest." Although not itself a flavor, it has the property of enhancing flavors of such foods as meats, poultry, fish, and certain vegetables to which it is added.

Poultry processors have long had a serious problem in disposing of feathers accumulating at the rate of from 50,000 to 70,000 tons annually. The feathers are wet, frequently mixed with blood, manure, and other refuse, and are subject to rapid deterioration. The bedding and upholstery industries are the largest users of feathers in their natural state. Greatest demand is for clean, white waterfowl feathers, but not enough geese and ducks are produced in the United States, so chicken and turkey feathers are sometimes used. Feathers are also converted into a meal in areas where a considerable concentration of poultry exists.

Technique of processing feathers for meal is comparatively simple: the wet feathers are treated with steam at 40 to 60 pounds pressure and the resulting material dried in a rotary drier. The product is used chiefly as a fertilizer, but has possibilities as plaster-setting retarder, for the production of foam-producing compounds used in fighting oil fires, in waterproof glues, in combination with phenolic type synthetic resins for molded products, and as a protein feed supplement.

Of the 150,000 tons of poultry offal (heads, feet, and inedible viscera) available each year at centralized eviscerating plants, most is used fresh as hog feed and fertilizer.

The most important by-products of the meat packing industry are the fats. They represent as much as 18 per cent of the sales value of the products of the plant. Edible animal fats are produced exclusively in meat packing plants, while the inedible fats are produced partly by meat packers and partly by independent renderers. Edible fats comprise lard from hogs (amounting to about 90 per cent of the edible fats), and oleo oil, oleostearine, and edible tallow from cattle and calves, as well as edible mutton tallow from sheep and lambs.

Inedible fats produced by the packers comprise inedible lard (greases), and inedible tallow, the latter amounting to about 75 per cent of the inedible fats, and derived chiefly from beef. Production of inedible fats amounts to around 2.6 million pounds annually. Ten years ago, slightly over 80 per cent of these fats went into soap making, but with the growing replacement of soap by synthetic detergents, only about 45 per cent is now used for soap making. Therefore research has sought new uses for this waste product. A process for making an improved grade of oleic acid (known in the trade as "red oil"), used chiefly as a constituent of textile lubricants and greases, has been evolved by scientists of the U.S. Department of Agriculture. Production of this improved type of oleic acid has an estimated value of close to a million dollars annually. Other uses for inedible animal fats are as a constituent of animal feeds, as a substitute for imported palm oil used in hot-dipping steel plate for cans, and as epoxidized fatty products used as plasticizers for vinyl chloride polymers and co-polymers.

Other important waste products of the meat packing industry are blood, hides, bones, hair, tankage, and glands. The last named, with an estimated annual

(*Concluded on page 212*)

California Fruit Growers Exchange

Filtering citric acid liquor obtained from waste lemons. About two million pounds of citric acid are produced yearly from lemons, and used in foods, beverages, and pharmaceuticals.

Engineering Education at the American University of Beirut

THE American University of Beirut is located in Beirut, Lebanon, the gateway to the Middle East. This little country at the east end of the Mediterranean is the most modern and liberal of the Arab Middle Eastern countries which include Syria, Jordan, Iraq, Saudi Arabia, and a number of smaller states such as Kuwait and Yemen. These states and the closely surrounding areas, lying on the bridge between Europe, Africa, and Asia have been, through the ages, important in cultural and military history and are today of the greatest strategic importance.

The university was founded by forward-thinking missionaries in 1866 under a charter from the state of New York and has operated practically without interruption in spite of many vicissitudes including two world wars.

Its campus is one of the most beautiful in the world overlooking the ever-changing Mediterranean and the often snow-capped Lebanese Mountains beyond the harbor. Its buildings and equipment are such as are found on any American campus. The language of instruction is English and the textbooks are, for the most part, American. To the amazement of most visitors its students in language, dress, and manners seem to create the atmosphere of a typical American University.

During its history the university, by virtue of its liberal Christian teaching, became a center for advanced thinking and from it many of the present-day leaders of the Middle East derived their knowledge and strength. Because of its educational service and the encouragement and assistance rendered in the struggles against the Ottoman Empire, and later against the French, the prestige of the University and of America was unbelievably high until the establishment of the state of Israel.

Though it is presently getting some assistance, primarily scholarships, from the American Foreign Operations Administration (Point IV Program) it is fundamentally a private institution with both the important educational potentials and the acute financial problems of such institutions. The great strain of attempting to secure the necessary general financial support was undoubtedly the primary cause of the death of its recent president, Stephen B. L. Penrose, Jr.

The Middle East

The area known as the Middle East has witnessed the emergence of man from the most primitive level and his development to some of the highest cultures the world has known. It has witnessed the rise and fall of states and civilizations. This particular bit of coast line has felt the flow and ebb of conquering people from prehistoric times, including such familiar recent groups as the Greeks, Romans, Crusaders, Mongols, Turks, French, and English. During the Middle Ages this area was the repository of the literature and science of the ancient world and from here it was reintroduced into Western civilization. Here were founded the three great monotheistic religions of the world.

Near Beirut are archaeological finds which go back more than 5,000 years. And within the Middle East area are the remains of some of the most colossal, beautiful, and useful structures ever built by man, such as the temple at Baalbek, the Palace of Xerxes, and innumerable irrigation works including those of the Tigris and Euphrates Rivers. Here our engineering forebears diverted rivers, constructed canals, and with piles of stones even artificially snatched, from reluctant clouds, water in sufficient quantity to supply villages.

Meanwhile for hundreds of years the forests were being stripped. Then accelerating this process there came a period of war and pillage – the crusaders, Genghis Khan, and others. The capital and momentum of civilization were dissipated, hydraulic works destroyed or neglected, and the effective control of water was lost. With the failure or uncertainty of water, life became precarious and the culture one of scarcity. The area inherited a primitive agriculture which even now appears much as it must have to Alexander, Caesar, and Christ, and includes nomadic herders though these are fast disappearing.

The Middle East Today

Though many of the present countries have adopted the forms and appearance of democracy, the spirit of the organization and administration is still fundamentally feudal. The culture of most areas holds women in low status and the children are tightly controlled by the family. Much of industry is still in the handicraft stage – some forms of which, though often of high quality, are not generally suitable for trade because of lack of quality control.

Trade is too largely on the individual, time-consuming bargaining basis and prices are the maximum the traffic will bear with little or no regard for the value of repeat orders.

Life, for the vast majority, is hard and unemployment and emigration high. It is the remittances of hundreds of emigrants to America and Africa who must often leave their families behind which, particularly in the Lebanon, very largely account for the balancing of the family and the national budget.

All these conditions are now in rapid transition for the better – primarily as a result of the exploitation of oil, the effect of two world wars, and of the improvement in education, communications, and travel. Lebanon (and Beirut in particular), with the relatively cosmopolitan outlook of a seaport, is the most ad-

Modified to Meet Extraordinary Conditions, American Methods of Engineering Education Help Bring Technology to the Middle East

By EDWARD S. HOPE

vanced in the transition and real progress is being made in industrialization. Iraq through the work of its development board seems likely to lead the way in public works of which the most important are flood control and irrigation works on the Tigris and Euphrates Rivers.

The resources derived from oil are making possible the redevelopment of the oil rich countries and also attracting development capital to these and to some of the other countries. Some of the projects like the distillation of sea water for domestic water supply in Kuwait may be forerunners of similar projects in other parts of the world.

Needs

During and following World War II the countries of the Middle East obtained real or nominal independence. With the development of oil and the resurgence of trade and related developments the need for trained local personnel in all fields became urgent.

The American University of Beirut and other institutions had prepared many men for various government positions. Schools of Engineering had been established in Egypt, Syria, Iraq, Iran, and Lebanon. In Beirut the French Faculty and A.U.B. had been preparing civil engineers. Some young men had studied in the United States, England, and on the Continent. There was then, a relatively large number of engineers and plenty of labor but a scarcity of technically trained craftsmen particularly in heavy construction and industry.

The great development projects call for the education of many more professional engineers and technicians. Experience has shown that these can be educated more successfully and at less expense within the area since the education obtained in the United States or in European countries is not specially adapted to the culture and problems of the Middle East. The provision of suitable educational opportunities is therefore one of the primary needs of the area.

The great need and justification for the existence of the A.U.B. Faculty of Engineering is the offering of a superior quality of engineering education and graduate work on a regional basis.

Faculty of Engineering

The Faculty of Engineering was established as a result of a careful study of the needs of the Middle East. The idea was approved by alumni and leaders. Financial supporters were found of whom Stephen D. Bechtel was one of the most important. The purpose of the Faculty is to serve the Middle East by providing the necessary educational opportunities and assisting in the development of its resources with particular regard to engineering, much as the university had earlier exerted a leadership which contributed so largely to the political independence and development of the Middle Eastern countries. In the transition which is changing the area from feudal agricultural communities to modern states in which technology and industry are developing rapidly, the A.U.B. is exerting leadership in engineering education which is adapted to the conditions and needs of the area.

In May, 1951, on the recommendation of the newly appointed dean, C. Ken Weidner, the writer was invited by the president, the late Dr. Penrose, to participate in the establishment and development of the Faculty of Engineering. At that time the university consisted of the schools of Medicine, Nursing, Pharmacy, and Arts and Sciences. The latter included a department of civil engineering which had been in operation since 1940.

The School of Engineering began operation in the fall of 1951 by taking over the existing program leading to the B.Sc. degree in civil engineering and establishing a new program leading to the bachelor of civil, mechanical, electrical, and architectural engineering. In the fall of 1952 we occupied the new engineering building which had been planned and its construction supervised by the faculty of the School. This is a modern reinforced concrete structure with a floor area of 50,000 square feet. The capacity of the plant has now been further increased by the addition of two other buildings totaling 38,000 square feet and containing shop and drafting room space. Due to the shortage and unreliability of electric power in the city, what had been planned simply as a power laboratory has for the past three years been supplying heat and electricity to the group of engineering buildings and also to the central university library.

Educational Requirements

In developing an educational program it was necessary to keep in mind the professional engineering needs of the area, the accreditation requirements under the New York Board of Regents, and also compliance with local legal requirements. The latter problem, a heritage from the French mandate, grows out of a fundamentally different type of education than our American system. The French system emphasized theory and length of time in school, and the right to practice is based on the engineering degree itself, rather than on evidence of practical professional capabilities as determined by a professional board after graduation and a period of service.

Organization

The Faculty of Engineering of the American University of Beirut has been organized in three parts:

the School of Engineering, the Institute of Technology, and the Science and Service Laboratories.

After much consideration it was decided that the School of Engineering, the professional school, should prepare for the fundamental branches of civil, mechanical, electrical, and architectural engineering. Because of the importance of oil there is considerable interest in petroleum engineering but it was not feasible to offer this program. Although the demand for civil engineers will probably be the highest and for architectural engineers the lowest, it was decided that the economy could absorb engineers in all these branches. In 1955 we graduated a total of 34 students of which 15 were civil and only 3 architectural. Incidentally, the architectural course includes all of the structural work taken by civil engineers so that the architectural graduates should be thoroughly capable in the field of design.

The Institute of Technology is being established to provide educational programs for technologists in industry and area development. Service courses are provided in engineering technology for other schools in the university such as Agriculture and Public Health.

A technical and vocational school was originally conceived of as a means of more fully utilizing the equipment and specialized personnel which was necessary for the shopwork of the professional school and of also studying and helping to meet the very real need for the training of modern craftsmen and technicians such as electricians, machinists, and surveyors. Recently several other technical and vocational schools in Lebanon and other countries have been enlarged and improved with the assistance of the American International Co-operation Administration. Consequently our service in this field which really began only in the fall of 1953 will be reduced accordingly.

The Science and Service Laboratories were planned to utilize more effectively the great amount of equipment which is needed for instructional purposes but which would normally be used for only a small part of the time. As a service laboratory for construction and industry in the area, it is meeting a real need and justifying much more equipment than could be economically supplied for teaching our small student body. These laboratories and service facilities also provide an outlet for the specialized abilities of the teaching staff and a contact with the current problems within the area. The laboratories have rendered consulting services on structural materials, steam equipment, foundation conditions, geology and mineral deposits, including the reinvestigation of ancient iron mines.

W. Eugene Smith from Black Star

Problems

In addition to the educational requirements previously noted, there are certain problems arising from the multinational backgrounds of our students. Although located in Lebanon and subject to its laws, the university is essentially a regional institution serving the area as a whole with students coming from 57 different countries. Most of these countries have their own national universities which offer engineering training. These countries differ widely in language, religion, technical development, and educational and general cultural background.

The preparation given in the secondary schools is of fundamental importance but there is a wide variation in curricular content, quality, and language of instruction which is generally either Arabic, English, or French. All local students in the university are bilingual and most multilingual. They generally bring a good mathematical training but many are weak in science since the secondary schools provide practically no individual laboratory work and very little demonstration by the teacher. This is largely a matter of economics since pure mathematics requires little equipment and science laboratory equipment is not available to most secondary schools.

Although there is little, if any, congenital difference between peoples and students in various parts of the world, environment has emphasized certain characteristics. Individualism is one of the most outstanding characteristics of the people of this area. While this characteristic is valuable – and also contrary to Communism – some of its manifestations are not so happy for it tends to prevent political, economic, and social co-operation which are essential for the various phases of development of the area.

Individualism strongly influences the whole area from persons to states. Most businesses are individually owned and operated whether they be stores or engineering firms. The larger ones are often family enterprises but seldom partnerships and practically never stock companies. This naturally limits the size and effectiveness of businesses and retards industrial development. Individualism is also reflected in the lack of co-operation among the Arab states and contributed largely to the ineffective resistance to the establishment of the state of Israel, one of the most humiliating events in Arab history. Added to this are the divisive influences of religions and sects and the educational and political heritage from the mandates. France, in particular, through its promotion of the French language, institutions, and culture has left a long-standing and crippling schism in Lebanon.

Student Characteristics

Although our students are much like American students in many respects, the average American student is no match for his Middle Eastern counter-

part in the matter of language and politics. They know Arabic, their native language, and English partly because it is the language of instruction and partly because it is an important world language which they feel they should know. In addition the majority are fluent in at least one other language, probably French. These languages are not studied as a subject to be passed, as is too often done in America, but as a means of communication which leads into science, trade, and politics.

To the average American student, politics consists mainly of a bit of skulduggery recurring annually on the campus for a brief period and some distant echoes from the municipal, state, or national elections in which he somewhat vaguely understands he must take some part during later years. But to the Middle Eastern student, politics is a vital everyday matter. The average Middle Eastern student probably knows at least as much about American politics as an American student. He knows far more about the United Nations and international politics than the average American student because it is a vital thing to him. American and United Nations actions regarding Palestine and Israel have created a million Arab refugees (including perhaps himself). He follows international politics because a vote in United Nations may profoundly influence his life and within a few hours he knows that Russia has vetoed a measure that might have injured his country or his father's business. Long before he enters college he probably owes allegiance to some national party. Campus politics is based not on fraternities or clubs but on national and international political parties and the issues are too often national or international and masterminded by persons off the campus who often consider nothing more important than themselves and their party. If we try to convince students that the life of a student is a period of preparation and that if they study they will be better able to perform for themselves and their countries in the future the reply is that for them, "the future is now." In this they may be right!

One of the first characteristics to come to my attention was a paradoxical spirit of fatalism, defeatism, and cynicism combined with reluctance to admit individual inability. This area, and particularly the Lebanon, has been in the pathway of conquerors for thousands of years and the history of its city states, or larger units, has been one of various subjugations and vassalages with only brief periods of freedom. In general, governments are not looked upon as being of, by, and for the people but a source of privilege or handicap depending upon one's personal standing with the powers that be. Here are found some of the best and most enlightened laws in the world but they cannot be depended upon to operate impartially and effectively. Circumvention is expected whenever expedient. In the light of this general background and the all-pervading refugee problem there is a tendency for the students to feel helpless and any possible efforts they may make toward bettering conditions as futile.

On the other hand there is sometimes an exasperating reluctance to admit individual ignorance or inability. So often when one asks "Do you know?" or

Arthur Griffin

"Can you do?" he receives the quick reply "I know, I know," but the experienced teacher or employer proceeds to find out for himself whether the young man does in fact "know." Perhaps this "front" was a part of the pattern necessary for existence under the conquerors and the hard conditions of life which still exist, to a large extent, for most people. However, once students discover that they are not expected to know everything but to learn, they settle down to be generally eager and apt pupils.

One of our special programs, referred to as the "Cultural Sequence," includes a study of the development of social and political institutions, technology, art, religion, and philosophy and shows the evolution of Western civilization and particularly that of the United States. This was planned to give background, perspective, and encouragement. More recently the Egyptian revolution and other Arab successes have tended to reduce this spirit of defeatism and cynicism. Discussions and personal counseling also assist in overcoming this attitude.

Curriculum

The curricula represent the joint efforts of the faculty under the dynamic leadership of Dean Weidner and with the advice of various persons in the Middle East, England, and America who are concerned with professional education. They are under continual study and review by all parties concerned, including the students, with a view toward improvement and better adaptation to the conditions and needs of the region.

There have been two complete revisions of the curriculum: The first produced what is referred to as the transitional curriculum, covering four academic years of engineering study leading to the bachelor's degree. The second is the new curriculum covering

five academic years (four calendar years) of engineering study and leading directly to the master's degree.

The most specific curriculum requirement is the national legal enactment that the right to practice professional engineering shall be granted only after four years of engineering study above the French or Lebanese Baccalaureate Part II. A.U.B. and its larger secondary school affiliate have operated on the basis of an American four-year high school followed by four years of college-level work leading to the bachelor of arts degree.

Students enter the School of Engineering after completing the freshman year at the university with a science major which includes college mathematics, physics, and chemistry. The B.Sc. degree in civil engineering has been granted after four academic years of study of engineering. Recently, by setting the Lebanese Baccalaureate Part II as the legal equivalent to completion of our sophomore rather than the freshman year as in the past, the government made it necessary for us to add one year to our curriculum in order that our graduates could meet the *legal* requirements for license to practice. Thus our students now require six years of study on the college level, or one more year than is required in the local or French system of education.

Another incidental legal requirement is that concerning the System of Measurements. The metric system, with the inclusion of a few ancient local terms, has been legally adopted throughout the area. American and English engineering textbooks use English units. In instruction we must use both.

The School of Engineering operates on a continuous basis involving four full terms or quarters during a calendar year. This has several advantages. It permits a higher utilization of plant and equipment than is possible on a two-semester basis. It reduces the elapsed time necessary to qualify for a degree. It is further supported by the fact that student work opportunities are so limited in this area that very few students could obtain work during a summer vacation and those who do can earn little more than subsistence, if that. Consequently it is desirable to hurry them on through school to graduation after which their employment opportunities are enormously increased. In order to keep students from going stale under the continuous load, there is a two-week break between each term and in the summer term there is an emphasis on shop, laboratory, and field work.

The faculty of Engineering at present has three programs of study on which students started in the fall of 1954. The first, which is essentially a master's degree program, involves five consecutive academic years (four calendar years) of academic study in residence after freshman pre-engineering. During this time the student is granted the degree of bachelor of civil, mechanical, electrical, or architectural engineering. He must then engage in engineering work for one year under engineering supervision which is approved by the School. After satisfactory completion of this apprenticeship the candidate will return to the School of Engineering for at least one term where he will prepare and defend his master's thesis and where he will be a participant in engineering seminars which will be conducted.

The second program involves a period of 13 terms or quarters of course work in residence and two terms of supervised experience on engineering work. One term of this supervised experience is scheduled to come at the end of the third academic year of study, and the other term after completion of studies in residence. This curriculum is less specialized than the former program. After satisfactory completion of this program, which covers four calendar years after freshman pre-engineering, the candidate will receive the degree of bachelor of engineering. The highest ranking graduates of this program may, upon petition, work for the degree of master of engineering. This will involve one additional year of course work in residence, one additional year of supervised experience, and the preparation and defense of a thesis as in the first program. These two professional programs are offered in the School of Engineering.

The third program which is offered in the Institute of Technology is not a professional program and does not qualify for license to practice professional engineering as do the first two programs. This consists of a total of four academic years in residence, *including* the freshman pre-engineering year and leads to the degree of bachelor of technology. No courses are offered during the summers, though students are expected to work on engineering jobs, hence this program is comparable in time requirement to the bachelor of arts degree which is offered in the School of Arts and Sciences.

These three programs are planned to meet the needs of the area with respect to professional engineering services and the required supporting services in technology. The first program leading to the master's degree is reserved for students whose peculiar capabilities will best fit them for advanced and specialized work, including research and the conception and design of unusual engineering works. The second program leading to the degree of bachelor of engineering is intended to produce the majority of the professional engineers – those who will perform the bulk of the general engineering work in the area, including the usual types of engineering design, construction, and general services.

The third program is intended to provide technologists who will occupy positions in the labor force between skilled mechanics and engineers, and under engineering supervision will be able to relieve engineers of some of the work they are now forced to perform, such as keeping of personnel and financial records and immediate field supervision.

The curriculum of the first three terms (one academic year) of all programs is identical, consisting primarily of the engineering sciences and shopwork. At the end of this period, those who elect or are selected for the program in technology begin specialized work. At the end of the fourth term, which is at the summer survey camp, students in the professional group who elect and are selected for architectural engineering begin a program which at this stage is slightly different from that of the other engineering students.

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THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Stratton Named Ford Trustee

HENRY FORD, 2D, chairman of the Board of Trustees of the Ford Foundation, today announced the election of Julius A. Stratton, '23, Vice-president and Provost of M.I.T., as a trustee of the Foundation. A native of Seattle, Dr. Stratton has long been associated with M.I.T. After one year at the University of Washington, he attended M.I.T. where he received the degree of bachelor of science in 1923. He then spent a year at the Universities of Grenoble and Toulouse, and returned to M.I.T. as a research associate in electrical communications, receiving his master of science degree in 1926. He was awarded the degree of doctor of science in mathematical physics from the Eidgenossische Technische Hochschule of Zurich in 1927, and remained in Europe on a traveling fellowship from M.I.T. studying principally at the Universities of Munich and Leipzig. Dr. Stratton was appointed assistant professor of electrical engineering at M.I.T. in 1928. In 1930 he tranferred to the Department of Physics and became professor of physics in 1941.

When the Radiation Laboratory was established at M.I.T. in 1940, some 14 months before Pearl Harbor, Dr. Stratton was one of the first members of the staff. In 1942 he was detached from the Laboratory to become expert consultant in the Office of the Secretary of War. During this period he organized a series of technical advisory committees to the Air Forces on programs of ground radar, radar fire control, and radar bombing. His final task was that of assisting in the establishment of a development program for aids to all-weather flying. In recognition of his outstanding service, Dr. Stratton was awarded the Medal for Merit on December 2, 1946, by Robert P. Patterson, Secretary of War. He was chairman of the Committee on Electronics of the Research and Development Board from 1946 until 1948.

Following the termination of the Radiation Laboratory, Dr. Stratton established the Research Laboratory of Electronics at M.I.T. and acted as director until he was appointed provost in 1949. He is the first academic officer to serve the Institute in the post of provost. He became vice-president and member of the Corporation of M.I.T. in 1952.

Dr. Stratton is currently serving as chairman of the Naval Research Advisory Committee, and is a member of the Army Scientific Advisory Panel. He is a member-trustee of the Rand Corporation — a nonprofit organization engaged in research for the United States Air Force and other government agencies; a trustee of the Boston Museum of Fine Arts; a member of the Corporation of the Woods Hole Oceanographic Institution; a fellow of the American Academy of Arts and Sciences, the American Physical Society, the Institute of Radio Engineers, and the National Academy of Sciences.

New Director of Libraries

RESIGNATION of Vernon D. Tate as Director of Libraries at the Institute was announced late in December by Julius A. Stratton, '23, Provost. William N. Locke, Head of the Department of Modern Languages, has been appointed to succeed him. Dr. Tate, who will retain the rank of professor at the Institute, has been granted a leave of absence of one year beginning January 1, 1956, and in mid-January he left for Italy where he will undertake a survey of libraries for the Department of State. He will also conduct seminars at various universities in library techniques.

"Under Dr. Tate's direction, the libraries have had their greatest period of growth in the history of the Institute," Dr. Stratton said. "He has made a notable contribution to our library system.

"Dr. Locke has long had an interest in the problems of the modern technical library and in problems relating to scientific aids to learning. He is especially well known for his interest in the complex field of mechanical translation and in the application of scientific knowledge to the study of language. Dr. Locke has led M.I.T.'s Department of Modern Languages, which he will continue to head, in pioneering work in these areas.

A native of Watertown, Mass., Dr. Locke did his undergraduate work at Bowdoin College and took the degrees of master of arts and doctor of philosophy at Harvard University. He has been head of the Department of Modern Languages at M.I.T. since 1945.

Prior to his appointment at M.I.T. he had been a member of the faculty at Harvard and during World War II he served with the Office of War Information. This service included an overseas assignment with a Psychological Warfare unit. Dr. Locke is regional representative for New England of the American Association of Teachers of French. He is former vice-president of the Association and is a member of its executive committee. He has also been active in the Modern Language Association.

Dr. Tate came to M.I.T. in 1947 from Washington, where he was director of photography at the National Archives. During the period he has been at the Institute, the Charles Hayden Memorial Library has been built, the Dewey Library has been established at the School of Industrial Management, and the total of volumes in the libraries has grown from 400,000 to 550,000. A specialist in microphotography, he has increased the use of scientific aids in libraries at M.I.T. and was one of the leaders in establishing a national plan by which doctoral theses are made available in microfilm form all over the country.

A native of Mt. Carmel, Ill., Dr. Tate received his bachelor's, master's, and doctor's degrees at the University of California. He was engaged by the Library of Congress to microfilm documents in Mexico for the historical collection of the United States.

M.I.T.C.O.N.Y.

A NEW era of activity for the M.I.T. Club of New York was inaugurated on November 1, when its new quarters on Floor One of the Hotel Chatham were officially opened in a gala evening event. With the advice and assistance of G. Peter Grant, Jr., '35, former President of the Club, and Harry K. White, '99, A. Louis Bruneau, '38, President, cut a cardinal ribbon to mark the official opening, as shown by the illustrations above and to the right.

The inaugural ceremonies produced a veritable deluge of Alumni, Alumnae, and their spouses, who came from all parts of Metropolitan New York to celebrate the Club's new "home." Before the evening was over, more than 500 members and guests had visited the Club. Such a gathering is the largest in the Club's history, and probably also sets a record attendance for any of the 92 Technology Clubs throughout the world. Many past presidents of the Club were in attendance at the opening – including Thomas D'A. Brophy, '16, W. Joseph Littlefield, '17, Alfred T. Glassett, '20, C. George Dandrow, '22, Raymond C. Rundlett, '22, Samuel H. Reynolds, '22, and Mr. Grant.

As may be surmised from the illustration above, even standing room was at a premium at the height of activities. Fay S. Lincoln, '22, served as official photographer and found considerable difficulty in obtaining sufficient room to make the interesting group of record photographs that mark the occasion. Mr. Lincoln's photographs have frequently graced earlier issues of The Review and it is a double pleasure that his present entry into pages of The Review records this historic New York event.

A pleasant reading room and lounge is available to members and visitors of the Club. In addition, a dining room is available and luncheons are served Monday through Friday at noon by the Club's own waiters, and on other days through the Chatham Hotel service. Dinner in the evening may be ordered daily except Sunday. The Club facilities also provide office space for Joseph E. Conrad, Executive Secretary, and Miss Patricia L. Hanna. The Club quarters are officially open daily from 8:00 A.M. until midnight.

The new facilities represent the outgrowth of a plan inspired by Mr. Grant, and put into effect by the Club's Board of Directors under the leadership of President Bruneau. Alumni are invited to visit the Club's quarters when in New York.

Photos – F. S. Lincoln

Egan Photo Service

Dr. James M. Faulkner (second from right), former Dean of the Boston University School of Medicine, was honored recently by his colleagues who presented to the School a portrait of him painted by William Draper. Participating in the ceremonies were (left to right): Dr. Chester S. Keefer, his successor; Burnham S. Walker, Professor of Biochemistry, presiding officer; sons Andrew and Henry Faulkner who performed the actual unveiling; Dr. Faulkner; and Dr. Paul Dudley White, friend and colleague of Dr. Faulkner's father (also an M.D.), as well as of the family, and teacher of Dr. Faulkner at Harvard Medical School.

Dr. Faulkner is now medical director at M.I.T. His family was well known in Keene, N. H., where the elder Faulkner was a physician for many years. Dr. Faulkner is a director of the New Hampshire Association for the Protection of Forests.

Compton Computer Center

A GIANT computer, first of a new high-speed type for education and basic research, is to be installed at M.I.T. Made available by International Business Machines Corporation, the computer will be the principal tool in a new electronic data processing center, plans for which were announced recently by James R. Killian, Jr., '26, President of the Institute, and Thomas J. Watson, Jr., President of I.B.M. In a joint statement Dr. Killian and President Watson said:

The development and application of electronic data processing is profoundly influencing the education and work of engineers, while at the same time the use of computers is rapidly spreading in science, government, industry, and business.

Great computing machines are making possible advances in research and analyses not hitherto possible and consequently are becoming essential tools for business and financial organizations. Educational institutions will make increasing use of them and will have a major responsibility to educate men and women to realize their full potentials.

M.I.T.'s School of Industrial Management plans to undertake a new program of studies in "operations research," the new field in which data processing methods are applied to manufacturing and distribution problems that are so complex they could never be solved by old-fashioned methods.

Other fields in which research is expected to be done include aerodynamics, where computations will lead to a better understanding of shock waves at transonic and supersonic speed; meteorology, where rapid assimilation of weather data can lead to better forecasting; atomic research, where calculations can throw new light on subatomic particles, and solid state physics.

Other colleges and universities in New England have been invited to share in the use of the machine for research and education of students in computing techniques. The computer will be installed, in early 1957, in the Karl Taylor Compton laboratories.

An advisory committee made up of representatives of New England colleges participating in the program will be formed to advise on such questions as priorities for problems to be submitted to the machine and the suitability of problems. Philip M. Morse, Professor of Physics, will be director of the Computation Center.

With a staff of more than 30 people, the M.I.T. Center will be the largest and most versatile data processing facility yet to be made available primarily for education and basic research. Not only will I.B.M. install the machine but will contribute to the cost of maintaining and operating it. The company will also make a grant supporting studies of research assistants to be selected from New England colleges.

Dr. Morse, the new director of the Computer Center, is a native of Shreveport, La. He studied at Case School of Applied Science, Princeton University, and the University of Munich. He joined the Faculty of M.I.T. in 1931 after a year in research at the Bell Telephone Laboratories and a year as lecturer at the University of Michigan. During World War II he directed research on sound control and underwater sound for the National Defense Research Council and was director of the Operations Research Group for the Navy.

In 1946 Dr. Morse became the first director of the Atomic Energy Commission's Brookhaven National Laboratory. He served for two years and then for one year as research director of the Weapons Systems Evaluation Group of the Joint Chiefs of Staff. He is a member of Scientific Advisory Committees for the Ordnance Department and the Bureau of Standards.

Administrative Appointments

THE number of applications for admission to the Institute has mounted steadily in recent years and is expected to continue rising at an even higher rate, B. Alden Thresher, '20, Director of Admissions, said recently in announcing four administrative appointments. In order to reconcile this increase with M.I.T.'s stabilized enrollment, the staff of admissions officers is being enlarged.

David A. Dudley, a member of the Institute's Faculty and Administration since 1945, has been promoted to associate director of admissions. Succeeding him as assistant director are Eugene R. Chamberlain, former assistant to Professor Thresher, and M. Bryce Leggett, '40, who comes to the Institute from the Sterling Textile Company in Springfield, Mass. John P. Anderson will join the staff early in 1956 as assistant to the Director of Admissions.

Professor Dudley, who served from 1945–1954 as instructor and assistant professor of English at M.I.T., was named assistant to the Admissions Director in 1948, and assistant director of admissions in 1951. Following his graduation from Harvard University, he held teaching posts at Phillips Academy, Andover; at the Berkshire School, where he headed the English Department; and at the Browning School, where he was also assistant headmaster.

Mr. Chamberlain joined the M.I.T. staff last year as assistant to the Director of Admissions, after five years with Downer-Honeywell and Company, Inc., and the Boston Woven Hose and Rubber Company. Graduated from Denison University in 1950, he had previously attended Albert College in Belleville, Ontario, Canada and served for six years in the United States Navy.

Mr. Leggett, chemist and treasurer of the Sterling Textile Company since 1945, had formerly held M.I.T. staff appointments as research associate in colloid chemistry, teaching fellow in chemistry, and research associate in chemical engineering. A graduate of Harvard College, he received his master's degree at the Institute in 1940.

Mr. Anderson, who attended Antioch College from 1948–1950, and served in the United States Marine Corps from 1951–1953, will receive the degree of bachelor of science at Boston University in February. At that time, he will come to M.I.T. as an assistant to the Director of Admissions.

Donald W. Taylor: 1900–1955

DONALD W. TAYLOR, '34, for 23 years a member of the Faculty of the Department of Civil and Sanitary Engineering, died on Saturday, December 24, 1955. He was 55 years old.

Professor Taylor, who was born in Worcester, Mass., received the degree of bachelor of science at Worcester Polytechnic Institute in 1922. He joined the M.I.T. staff 10 years later as research assistant in Civil Engineering. His promotion in 1934 to research associate was followed by successive appointments as Assistant Professor of Soil Mechanics and, in 1944, Associate Professor of Soil Mechanics. The Institute awarded him the degree of master of science in 1942.

Professor Taylor was a participant in the International Soil Congress in 1949. Several years ago when the Alumni Pool building at M.I.T. was built, he was a consultant on soil conditions for the construction of that building, and in 1951 he conducted studies on the characteristics of soil settlement for the Charles Hayden Memorial Library building.

AMERICAN UNIVERSITY OF BEIRUT

(*Continued from page 198*)

The curriculum for all other engineering students is identical through the first six terms (two academic years) of study, and consists essentially of engineering sciences and shopwork. After this the curricula begin to differentiate and selection must be made by the student in consultation with the faculty as between the basic or fundamental bachelor of engineering program and one of the four branches in the master's degree program. However, even in the third year, there is very little differentiation between the curricula of the different branches and all students take the elementary engineering courses which are fundamental in the several branches. This plan grows out of the condition of the area which still requires more of a general knowledge of engineering rather than high specialization. The organizational and financial problems are also reduced by deferring the differentiation and specialization as long as it is possible to do so.

Selection Process

Growing out of the above conditions and problems, a student enrollment limited to 350, and the great demand for places in the school, there was added to the usual process of comparing records, recommendations and interviews, a four-week qualifying program. In the summer of 1955 there were 120 selected students who took this program consisting of aptitude tests, engineering problems, graphics, shopwork, and athletics. Of these only 100 were admitted to the first-year class. Improved effectiveness in teaching this class over classes which had not been thus selected was immediately evident.

The separate qualifying program as such was discontinued after 1955. It is now incorporated in the work of the first term in engineering. It is expected that some of those who would normally be rejected for professional engineering will be found quite suitable for the field of technology. Also the time and effort invested in students, which is often lost when they drop out during the first or second year of engineering study, will be saved by those who will go into the technology program here at the end of the first year in the School of Engineering.

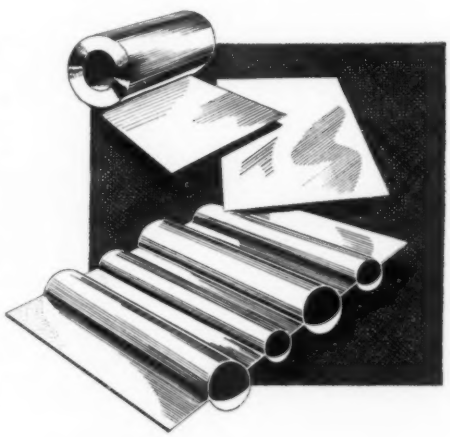
(*Continued on page 204*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

This is an announcement of an important new product, Revere Tube-In-Strip, available in copper, brass, other copper alloys, aluminum, and other metals. This is sheet or strip metal that is solid, not a sandwich of two separate sheets. It is rolled from a casting, yet contains longitudinal channels that may be expanded into tubular forms. The Revere method of production is unique and patents have been applied for.

After casting, the metal is rolled until the desired gauge is reached. It is shipped either in long coils, or flat. In the fabricating shop the metal is handled like any other coil or flat stock. In can be drawn, stamped, or bent, and then inflated by pressure applied inside the channels. Since the channels are properly spaced and sized to begin with, the tubes naturally have the same dimensional accuracy. Various numbers and sizes of tubes can be provided for in the same length of metal.



When inflated in the open, the tubes are round. By expanding into dies, the tubes can be made half-round, or given other shapes, such as rectangular, oval, fluted, hexagonal.

The immediately evident applications for this new material are in the field of heat transfer, as in automobile radiators, domestic and commercial water heaters and coolers, baseboard and ceiling heating panels, domestic and commercial refrigerators and freezers, and in the processing industries. Since the tubes and the web between them are integral, thermal conductivity is higher. The rigidity imparted by inflation adds to strength, permitting use of lighter gauges, thus again increasing conductivity, as well as saving in weight and price. Additional economies are achieved by the fact that the metal is sold and shipped as coiled or flat strip or sheet.

Those who have seen this new Revere product have been most enthusiastic. It is stimulating new thinking by designers, engineers, and production men, and there is no doubt that they will come up with numerous ways to use Tube-In-Strip that Revere has not thought of. Like other members of the copper, brass and aluminum industries, and indeed, all American industries, Revere does not stand still. Let us suggest that you keep in touch with modern developments, no matter what you buy, or from whom. Ask your suppliers to report what they have that is new, and see if you cannot make use of it.

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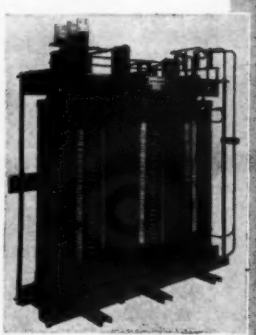

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Chester Meyer, '36, *Works Manager*

AMERICAN UNIVERSITY OF BEIRUT

(*Continued from page 202*)

To qualify for promotion each student must pa every subject and his work as a whole must be co sidered as satisfactory, that is, it should be above th minimum passing grade. If a student fails to pass course when required to repeat because of failur he is dropped, or if in the professional school he may be allowed to transfer to the technology program.

Some students have marginal grades in the first year but because of language difficulties, limited back ground, or other special conditions have not pro duced up to what is considered their real potential. In a few cases such students may be permitted to spend an additional year between Engineering I and II in a special program of engineering sciences, mathematics, and language practice.

Teaching Methods

Once the student is admitted, his lack of techno logical background becomes evident and complicates the problem of teaching. His American counterpart grew up with mechanical toys, has operated and re paired bicycles, automobiles, and so on, and has live in a culture of technology. For the most part students have not had this opportunity. Indeed som may not even have seen a wheel until they were well along in years. Thus the array of mental images technical terminology that is brought to engineer school by most American boys is almost wholly la ing. Some boys have suffered from an "effendi" com plex in which an upper-class boy would not think working with his hands.

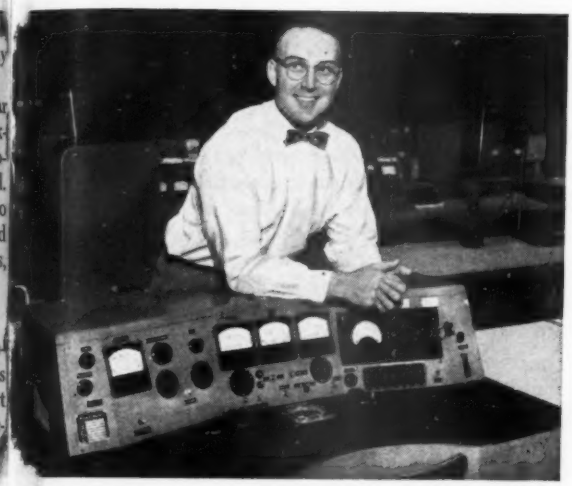
Furthermore although there are many well-ed cated engineers in the Middle East, the working force of well-trained, well-paid technicians (which i Western countries is supervised by engineers) is al most nonexistent in the more recently developed trades such as the plumbing and electrical trades, for example. As a consequence, engineers on a job must generally accept very inferior workmanship or must be able not only to properly supervise but also to actually instruct tradesmen.

Thus a heavy program of shop, laboratory, and related graphics was considered essential to make up for a cultural background which is weak or almost lacking in technology, to overcome the snobbish aversion to manual work, and to provide graduates with enough familiarity to properly supervise tech nicians and if necessary demonstrate to them the proper methods of performance. It has been gratifying to see how quickly our students have abandoned the effendi complex and entered into shopwork with energy, enjoyment, and success.

In this connection the techniques as well as the fundamentals of surveying are being taught. In con trast to the action of M.I.T. in discontinuing the Surveying Camp because it does not have time to teach both the fundamentals and the techniques, we have gone to considerable effort to establish a camp Unlike conditions in America where a graduate work under close supervision of a professional engineer and can learn techniques after graduation, our grad

(*Continued on page 206*)

Young engineers making news at Western Electric



...hard C. Shafer, B.S. in mechanical engineering at Lehigh, ...as one of 16 engineers assigned to one of Western Electric's ...hest post-war projects — developing manufacturing tech-...es for mass-producing *(with great precision!)* the tiny but ...ing transistors which are already causing a revolution in ...bnics.

Paul J. Gebhard, B.S. M.E. at the University of Maryland, was one of a team that helped develop Western's new electroforming process for coating steel telephone wire with copper, lead and brass in one continuous operation. His job: to develop conductor resistance-annealing equipment and electrolyte filtration and circulating systems.

Bobby L. Pettit (at right), an E.E. from Texas A. & M., is one of several hundred members of Western Electric's Field Engineering Force. These F.E.F. men can be found all over the world — working most closely with the Army, Navy and Air Force — advising on the installation, operation and maintenance of complex electronic equipment made by W.E.

Western Electric's primary job — which goes 'way back to 1882 — is to make good telephone equipment that helps Bell telephone companies provide good service. It's a very big job — and a very important one — which calls for the pooling of varied types of engineering skills.

New manufacturing processes and methods are constantly required to produce better telephones, better central office equipment, better wires and cables, new types of electronic equipment to keep pace with the nation's ever-growing need for more and better telephone service at low cost.

In addition to doing our job as manufacturing unit of the Bell Telephone System, Western Electric is busy producing many types of electronic equipment for the Armed Forces. Here again, young engineers of varied training are doing important work in connection with the manufacture of radar fire control systems, guided missile systems and special military communications systems.

Western Electric offers career opportunities for engineers in all fields of specialization. For details write for a copy of "Your Opportunities at Western Electric". College Relations Dept., Room 1034, Western Electric Co., 195 Broadway, New York 7, N. Y.

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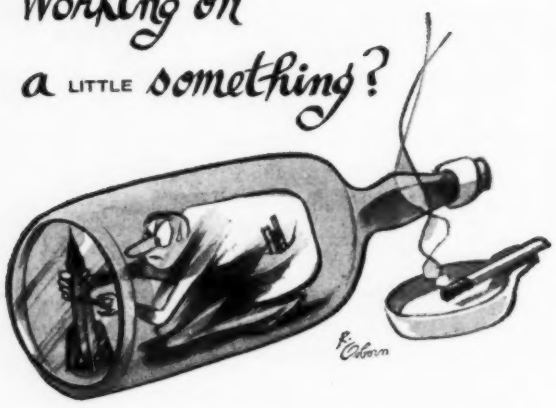

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AMERICAN UNIVERSITY OF BEIRUT

(*Continued from page 204*)

uates are licensed to practice upon graduation and because of a shortage of engineers frequently find themselves in responsible charge of a project of substantial size only a few weeks after graduation. Under these conditions we feel it necessary to teach as much of the techniques as possible in addition to the fundamentals. In this the writer is reminded of the interesting stories of the late Professor Edward F. Miller, '86, which illustrated his idea that any graduate of any branch of engineering at M.I.T. should be able to meet any situation within the area normally assigned to mechanical engineers.

The pressure required to accomplish all this is terrific and the students here have a program of study which is even more demanding than those in the United States. Visual aids, slides, moving pictures, models, and sections of moving parts of machinery and instruction in the laboratory are utilized to the maximum in order to facilitate the acquirement of vivid and tangible experience in place of the previously mentioned lack of opportunity and technological background.

In order to save students' time and also give training in sustained attention and effective use of time, laboratory reports are completed and handed in before the student leaves the laboratory.

Because the virtue of individualism has been carried to a vice it is a matter of educational importance. In order to develop the spirit and habit of co-operation definite steps are being taken. The student body is organized into small groups each including members from all classes and under the leadership of a senior. The function of these groups is primarily one of mutual concern and assistance in scholastic and extracurricular matters and gives the senior the opportunity to gain experience in organization and supervision.

Shop and laboratory work is done on a teamwork basis whenever practicable. Extracurricular activities which include athletics, orchestra, show, yearbook, student society and other projects are also carefully supervised with a view to the development of initiative, co-operation and more especially responsibility. A special feature of the extracurricular activities is the student corporation which, with the senior class acting as the board of directors and the student body

(*Continued on page 208*)

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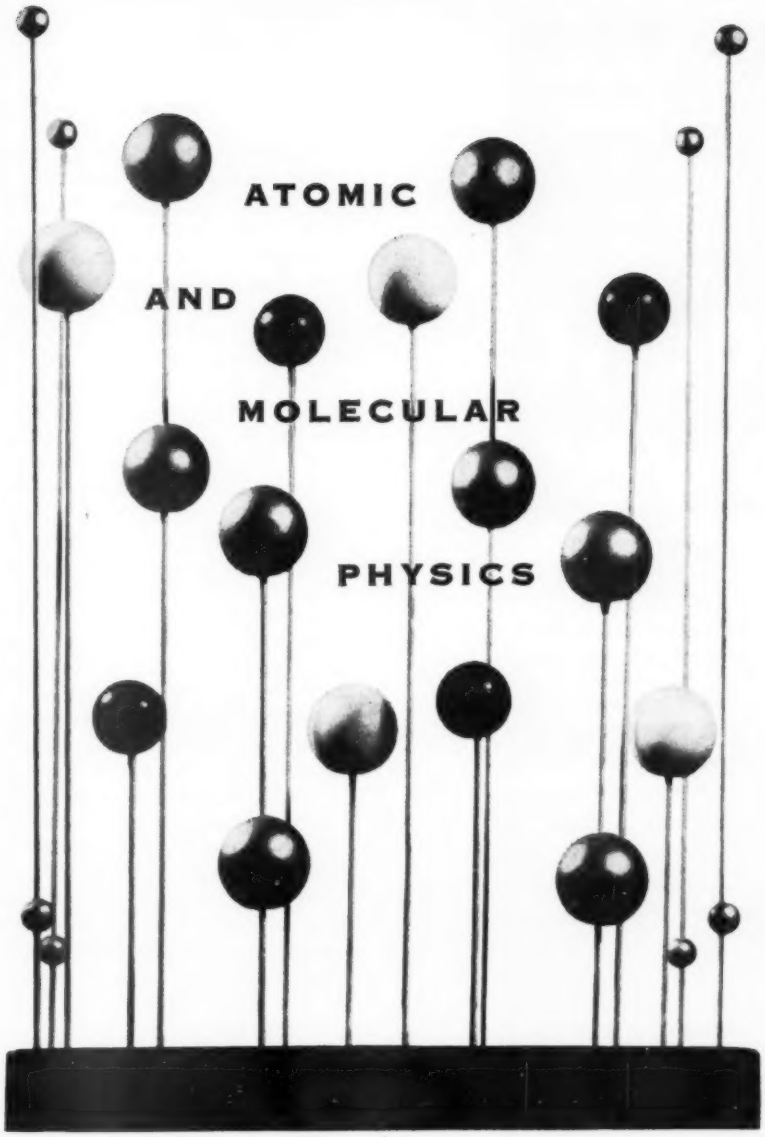

Molecular structure model, courtesy California Institute of Technology

The Hughes Research Laboratory is pioneering in long-range fundamental research in the field of radio, microwave, and millimeter spectroscopy, atomic clocks, atomic and molecular amplifiers, and frequency standards. Techniques using gases, liquids and solids are employed.

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(*Continued from page 206*)

as a whole as stockholders, is responsible for supervising the routine operation and maintenance of the building. In developing co-operation we feel we are promoting the welfare not only of our students and graduates in engineering ventures but also, in the long run, the general development of the area in economics, social welfare, and government.

Much of the business of the area, particularly in Beirut, is trade rather than production and the trade is far too much based on "sharp" practices rather than integrity. This may have grown out of centuries of life, based largely upon trading in an economy of scarcity, in which existence depended more on driving the sharpest possible bargain than on individual production.

This may account for a more than normal attitude of admiration for the successful cheater when applied to students. Also, cheating was encouraged by the old local system of education which consisted largely of memory work. In promoting honesty in weekly quizzes and examinations we use drafting tables which are arranged so that adjacent students are never taking the same quiz or examination. Examination questions are also almost invariably mimeographed and mostly of the open-book type. Since the system makes it almost impossible for students to communicate with each other, and since they have no need for "ponies," our students are finding it no longer tempting to cheat. We hope that these and other measures will so develop the habit of honesty that it will remain after graduation. The weekly quizzes also encourage sustained effort in each course and make it impossible to prepare for an announced quiz in one course to the neglect of other courses.

Although the language of instruction is English all Arabic speaking students divide their time in the cultural sequence between English and Arabic discussion and their papers and reports in this sequence are required in both English and Arabic so that graduates will not lose contact with their people and will be able to communicate with them with facility.

Creative individuality is promoted by small classes of not more than 25 students. Although there may be one joint lecture each week to the several sections taking one course, there are at least as many recita-

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tion-discussion periods for each section so that each student gets individual attention and opportunity to express himself. This is further promoted by the practice of comprehensive examinations in the third and fourth years and a final year project to which is allocated about one third of the time of the final year and which requires the individual investigation and solution of a practical engineering problem.

Throughout the program of study, we try to emphasize a co-operative and constructive approach to local conditions and problems. In lectures local material is given by way of illustration as often as possible and class problems and quizzes are oriented toward local problems whenever possible. Each student now works one summer just before graduation on a local construction job or in a local factory or other establishment.

The final year project gives a culminating emphasis on local problems. For example each civil engineering student for the past two years has investigated and planned a section of a proposed Beirut-Damascus Highway. The Government has requested these studies and has used them as a basis for its future plans for development.

Results

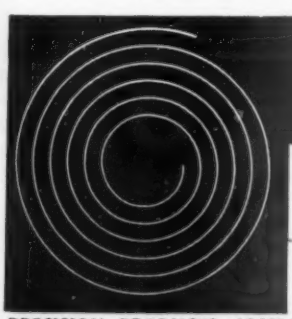
It is a little early to attempt to measure our results accurately. Only last year did we graduate the first group which we have seen all the way through. Our curriculum and teaching methods have been undergoing continual study and modification and we have been expanding rapidly. All our graduates are employed in engineering work or are pursuing advanced studies. In both fields they all appear to be successful. We try to maintain contact with them and to encourage their constructive criticism and advice. In this they have been honest and helpful and improvements have resulted.

Observations

The foregoing has been all about one school – its objectives, problems, and plans. Yet it is probably typical of the kinds of things that many American teachers are meeting in the far places of this much smaller world.

Those of us who, as teachers, Point IV workers, or military or state department employees, are privileged to work or teach in foreign countries have an opportunity and a duty. We must recognize and deal with different cultures, often with vastly different histories

(*Concluded on page 210*)



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(Concluded from page 209)

and values. We and our families are guests and have the responsibilities of learning and understanding the background and conditions of living which determine customs, ideas, and action. So far as possible without violating moral principle we must conduct ourselves as will best accomplish our purpose which, although it may be partly selfish, is still probably a more altruistic plan than has ever before been undertaken by any country or nation in the history of the world.

We are welcomed or tolerated, as the case may be, because of our reputation as producers, technologists, and engineers. Our hosts, knowing the value of these as commodities, are willing to trade with us. Even in the countries which we liberated no longer are we and our way of life really understood, accepted, welcomed, or loved. Any such advantages which we may have enjoyed have disappeared in most areas because of unsuitable representatives and inept political action. Now it is essentially our abilities (and money) which are wanted and which are being bought or traded.

Yet we cannot escape recognizing that our engineering and engineering education is not a unit of export commodity. It is in fact only a part of a total organism which might be called the American Way of Life, and without the proper functioning of the other parts of the organism, American engineering and "know how" would almost cease to exist.

Many countries and people would like to see our engineering and technical knowledge isolated and imported, but this is impossible. To realize our standards and to enjoy the satisfactions of life which they desire (and attribute to our peculiar resources and technical ability) many non-Americans must learn that all the fundamentals and corollaries are required.

American engineering has been developed in an atmosphere of integrity, of private enterprise, and of individual freedom. But freedom is coupled with responsibility – a responsibility to and for the people.

The joy and satisfaction of freedom is readily acknowledged by students and citizens of this and almost any area but the full acceptance of responsibility is a corollary which must be carefully taught. In this connection the study of the professional code of ethics is included in the curriculum and is used as a basis for living and, if necessary, discipline so that when the oath of the engineer is administered at graduation it is already a well-understood guide and should be an integral part of life.

Occasionally there have been charges and proof of graft and other evils in connection with engineering work in America. As a result we may sometimes forget that our vast engineering works can be carried out only because of the honesty and integrity of the overwhelming majority of people; without these our technology and our way of life would collapse.

As American citizens and as teachers we must be honest to admit to our hosts the shortcomings and failures in certain phases of our way of life. But we as teachers must do our best to live up to and hence teach the ideals of American life and a democracy based on responsibility.

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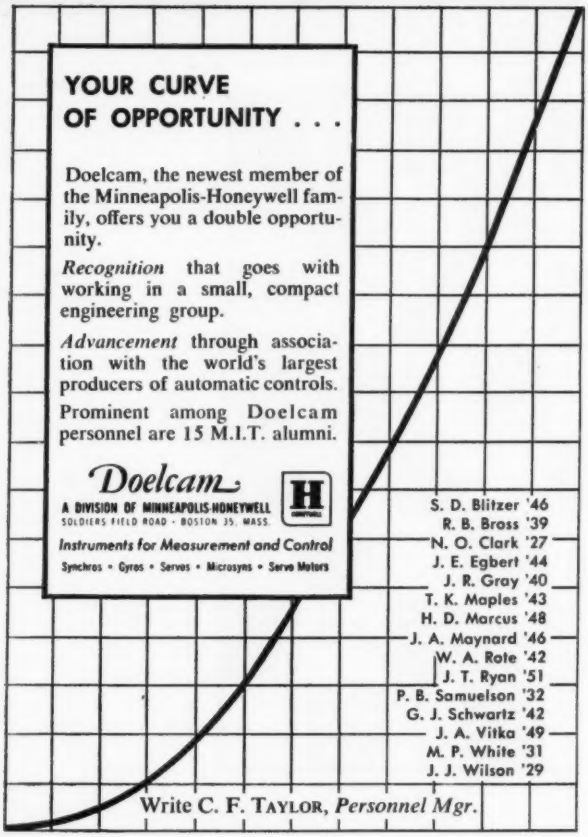
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DOLLARS FROM WASTES

(Concluded from page 193)

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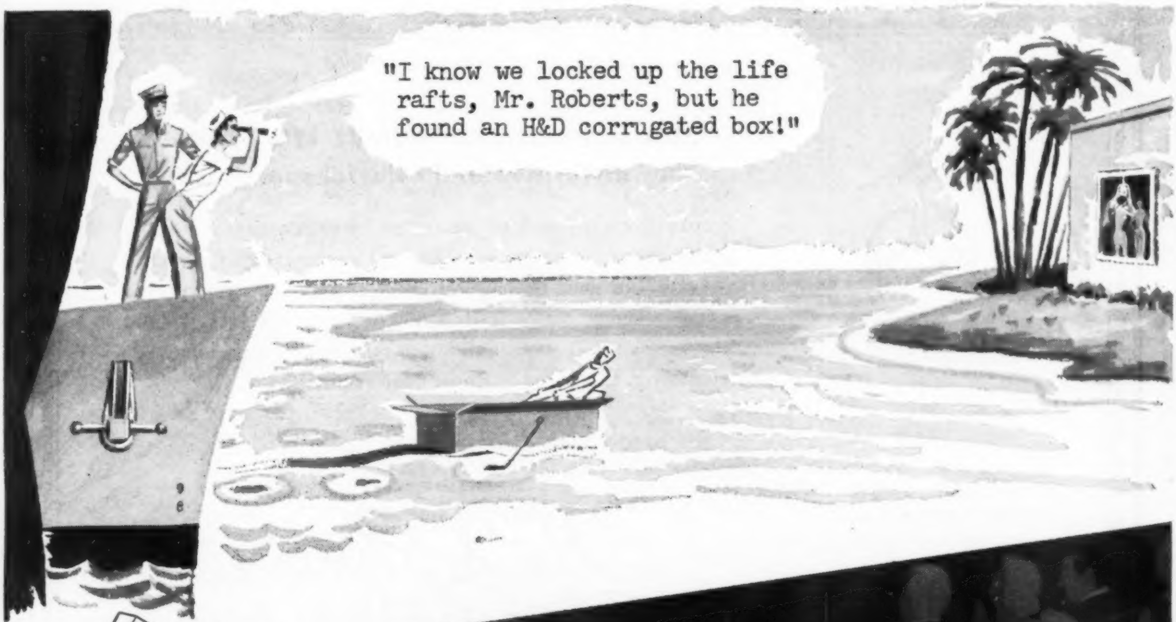

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TECHNOLOGY AND THE LIBERAL ARTS

(Continued from page 190)

some way could be found to restore even a part of this source through a more favorable and realistic tax situation, college treasurers might breathe a little easier as they study their forecasts. I cannot help but feel also that the loss to the university world when there is no longer a Harkness, or a Duke, or a Blair will be irreparable. The gifts they made to institutions carried with them a legacy of equal value to the money involved – some of the character and example of the givers.

The third possibility is the consideration of what the educational world itself might do in adapting to the conditions that confront it. In my own opinion, there are a great many changes in the accepted pattern of education that probably will have to be made.

What these will be, I cannot specifically say. As a representative of industry, I might suggest that the educational world survey American industry carefully to see if there are not some industrial practices which might bear transplanting to the educational field, just as so many educational techniques have been adopted by industry. For example, industry has long since learned that profitable operation is most easily obtained when facilities and equipment operate at maximum potential. In the chemical field, many of our plants operate a continuous process,

(Continued on page 216)

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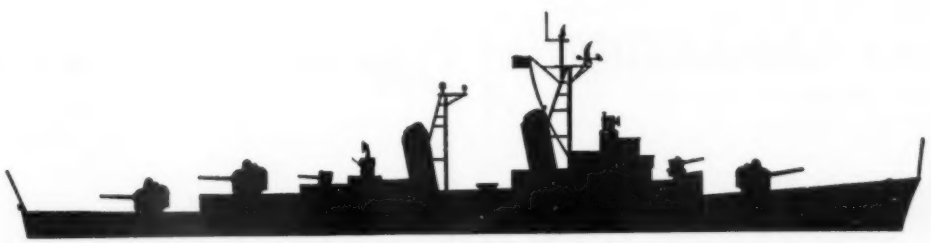

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TECHNOLOGY AND THE LIBERAL ARTS

(Continued from page 214)

and we have learned to adjust schedules of holidays and annual vacations to fit the needs of a plant that never closes down.

Suppose our schools and colleges were to adopt this system? By staggering the vacation period, we would be able to increase substantially the number of students accommodated without an increase of physical facilities. I see no reason why vacations must be confined to the summer season – in industry, we have learned to spread them out over the entire year, and the resort, travel, and recreational industries have now adapted their activities to this year-round principle. Perhaps the schools and colleges could do as well.

I believe that better planning and scheduling in the use of our facilities and equipment, even on existing schedules, would provide a handsome return for the effort. While I deplore the suggestion of mass production as applied to education, there is no doubt about the fact that some of the methods which have proved so successful in that area could be studied with some profit by our educational administrators. My own observation is that there are many instances of a laboratory or a shop which is overcrowded and inadequate in the afternoon, yet empty and silent for a good part of the morning.

There are other industrial practices which might well be examined. One is what we might call pricing policy. Like business, the universities have always tried commendably to keep the costs of an education down to reasonable limits so that more people could avail themselves of the opportunity. To this end, endowment income has usually been used to reduce tuition costs for everyone. Lower prices are indeed a laudable aim in business or college, but losing money is fatal for either. I wonder if we are not going to find that selling a $2,000 college year for $1,000 to anyone, regardless of ability to pay, is poor economics in the end and may ultimately deprive more people of education than it gives.

As a university trustee, I am glad to see that qualified students who can afford nothing, pay nothing, but I fail to see where an automatic subsidy for everyone can be justified.

Speaking of industrial practices, there is one other which should be included, although it is not related directly to the relief of the university's financial problems. There is no doubt that rising costs have added to the financial difficulties, and that this has had a serious effect on the vital question of faculty salaries. Industry, too, has had the problem of increasing costs, but it has long since learned that an organization is no better than its people and that only by providing adequate incentives can it attract and hold high-caliber personnel. The universities must inevitably follow, and I don't think there is any doubt that university pay scales must be raised. There is a good sales argument here, I suggest, for educators raising funds among industries: If there is anything industrial management knows, it is that good men come high, whatever the form of compensation. It could hardly argue that a different principle should apply in the universities.

In facing all these problems, education and industry need now, more than ever before, to maintain a close association. My suggestion is that all of us take immediate steps to look at our problems from a common point of view. One of the difficulties is that cor-

(Concluded on page 218)

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TECHNOLOGY AND THE LIBERAL ARTS

(Concluded from page 216)

porations, as well as our larger universities, have become national rather than purely local in scope and may have lost the intimate, personal relationships which prevailed in earlier times. The tendency is, therefore, to view problems in their very broadest terms and forget that the national scene is simply a projection of a number of local scenes and that problems can be understood best at closest range.

To industry people, I suggest that, while we are considering the problems of the universities generally, we address ourselves to the problems of some particular university specifically. If every member of industrial management would become sincerely interested in the problems of some university, either in his home town, his home state, or in one for which he has some special affection, we would have a practical and immediate approach to joint understanding.

To university administration, I suggest that the aid and the personal counsel of industrial leaders in your communities be actively solicited, not simply as contributors, but as active participants. I think there is much that each of us could learn from each other to our mutual advantage.

We need desperately to broaden our common understanding and common objectives. The future of both industry and education may very well be determined by how closely the two can work out their problems together. The need for co-operation is greater than ever before. I am confident that if we work together, we will find reasonable and satisfactory solutions to our mutual problems.

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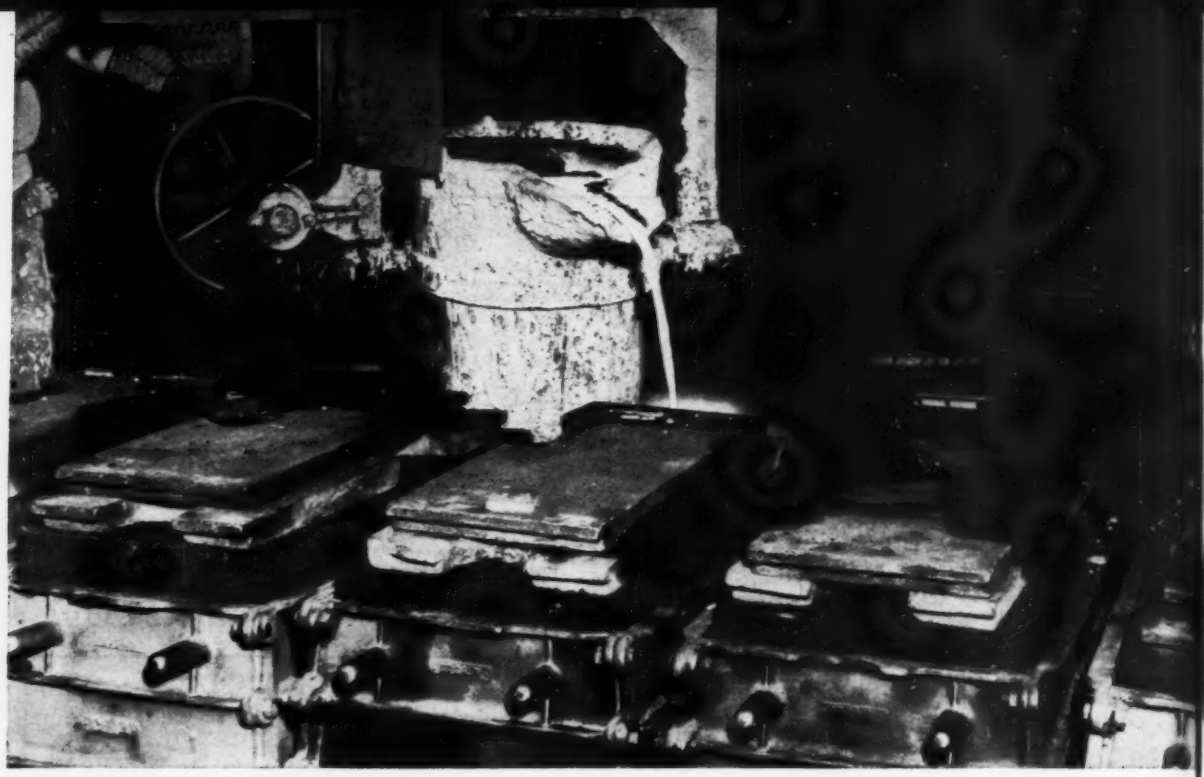

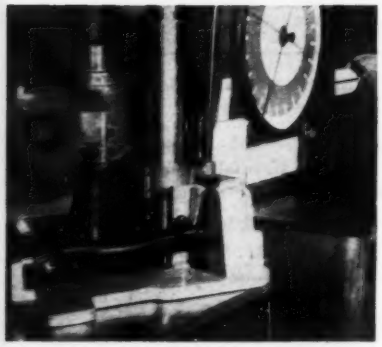

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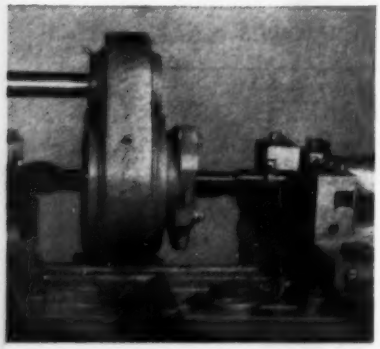

cision machine tools enable close tolerances
be held.

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Attention to detail — all along the line at Draper Corporation — brings you *important savings.*

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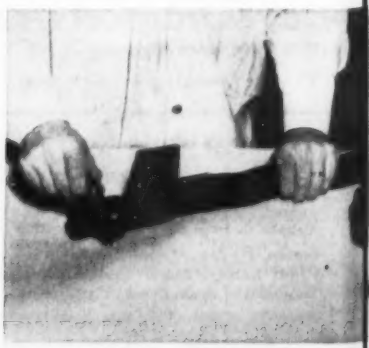

Use of gauges in final inspection perm
high standards of uniformity and quality
be maintained.

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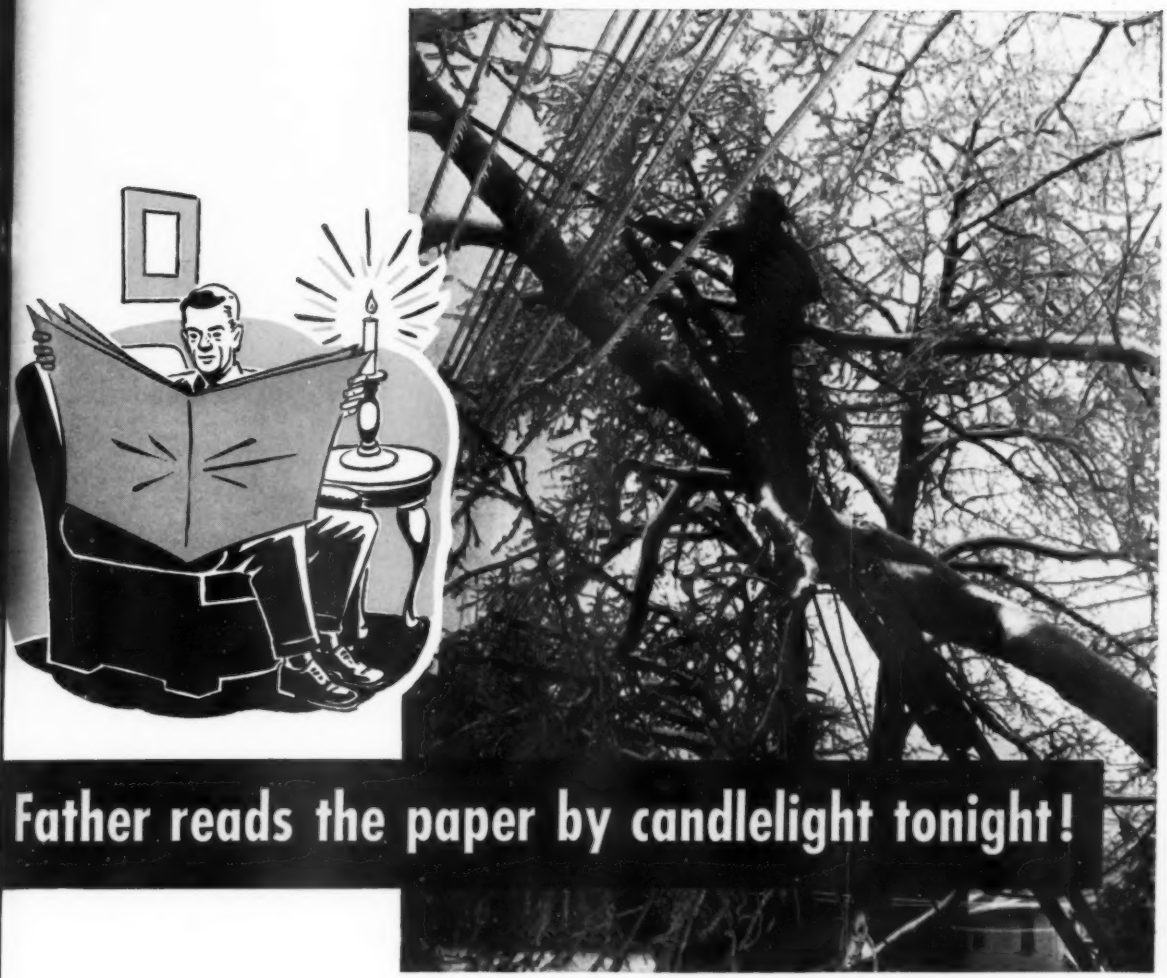

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Reading the evening paper by candlelight is no joke. When bad weather brings down distribution lines, customers' blood pressures go up and loads drop. Public relations programs suffer correspondingly.

That's why weatherproof line wires in utility distribution systems are being replaced by messenger-supported, insulated aerial cables. These cables will operate safely and dependably even with broken poles.

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Who and Why The Parker Appliance Company, Cleveland, Ohio, has found ultra-high-speed photographic techniques made possible by the G-R Microflash most satisfactory for this work. To quote Ned Shiflet, Manager of the Engine Accessories Division: "Flash bulbs of 1/80 second to 1/170 second light duration would not stop the high-velocity droplets in the atomized fuel spray. A commercially available high-speed electric flash with light durations as small as 1/30,000 second was also found unsatisfactory."

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